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# MILITARY IMPLICATIONS OF U. S. AND SOVIET NUCLEAR TESTING

Report by the Twining Committee

to

The Chief of Staff, U. S. Air Force

4 March 1963

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON 25, D.C.

REPLY TO ATTN OF: AFRNE

13 March 1963

SUBJECT: Corrigendum to Twining Committee Report, 4 March 1963

TO: Holders of the Report

The Committee has brought to my attention that during the final drafting and editing of the report an error was made on page 2, in interpreting and recording its views.

The Committee did not intend to imply that none of the Soviet test shots can be analyzed on the basis of U. S. technology nor that the United States has lost its technological superiority in the yield-to-weight ratio of warheads of the Polaris and Minuteman weight class.

To more accurately reflect the views of the Committee, it is requested that the following changes be made and this corrigendum be attached to the inside front cover of the report as authority for the changes:

Page 2, First Paragraph to Read:

The belief in a United States nuclear lead is based, in great part, on an assumed superiority of our nuclear deterrent forces, particularly, in the yield-to-weight ratio of warheads of the Minuteman and Polaris class. Although we may not have surrendered our superiority in this weight class, this embraces only a part of the yield spectrum. Moreover, we know that our missile systems are at present vulnerable to nuclear attack. Additional nuclear tests are required to insure the effectiveness of this missile deterrent force--on which greatly increased reliance has been placed by recent major decisions.

Page 2, Third Paragraph, First Sentence to Read:

In analyzing the Soviet shots, our data indicates that they cannot all be interpreted in terms of U. S. technology.

Ola P. Thorne

OLA P. THORNE
Colonel, USAF
Committee Executive Officer

Holder of
Copy No. 34

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4 March 1963

General Curtis E. LeMay
Chief of Staff
United States Air Force
Washington 25, D. C.

Dear General LeMay:

In response to your request of 20 August 1962, the Committee was reconvened to review the military implications of the 1962 U. S. and Soviet nuclear test series.

The Committee has completed its study and wishes to submit the attached final report.

Sincerely yours,

N. F. Twining

N. F. TWINING
General, USAF (Ret.)
Chairman of the Committee

Committee Member Concurrence

Dr. Simon Ramo
Dr. Theodore B. Taylor
Lt. Gen. J. H. Doolittle, USAF (Ret.)
Dr. John S. Foster, Jr.
Prof. David T. Griggs
*Dr. Conrad Longmire
Dr. Gerald M. McDonnel
Gen. E. E. Partridge, USAF (Ret.)
Dr. Edward Teller
Dr. Stanislaw M. Ulam
Prof. John A. Wheeler

Simon Ramo
Theodore B. Taylor
J. H. Doolittle
John S. Foster, Jr.
David T. Griggs
Conrad Longmire
Gerald M. McDonnel
E. E. Partridge
Edward Teller
S. M. Ulam - By Phone
John A. Wheeler

*See footnote on Page 4.

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# MILITARY IMPLICATIONS OF NUCLEAR TESTING

## I. INTRODUCTION

SEE CHAN.

In a preliminary report of 12 December 1962 (Appendix V), this Committee reviewed the evidence from Soviet and U. S. nuclear tests and recommended the establishment of a long-range, vigorous nuclear weapons development and effects program. Since that time negotiations for a test ban treaty have resumed, and the positions of the U. S. and U.S.S.R. have become sufficiently close so that a treaty agreement soon may be reached. Moreover, in this interval additional restrictions have been imposed on U. S. testing. Because of these developments, the Committee has focused its attention in this report on the military implications of the test ban.

Official recent statements have placed considerable emphasis on three premises to support the desirability of a test ban.

A. The U. S. holds a nuclear lead and is most likely to maintain it if there is a test ban treaty.

B. Nuclear technology has reached a point of diminishing returns and under a test ban no developments are likely to occur that can upset the balance of power.

C. The risks of a surprise abrogation can be reduced to an acceptable level by a national policy of maintaining strong weapons laboratories and test facility readiness.

The Committee examined these premises from a scientific and military viewpoint and concludes that they are not valid. A test ban would involve greater risks to the national security than perhaps have been realized. An attempt is made to explore these risks so that they may be weighed against the presumed advantages.

## II. MISSILE DETERRENT EFFECTIVENESS

SEE CHANGE MAR 13, 1963

We disagree with the first premise. The belief in a United States nuclear lead is based, in great part, on an assumed superiority of our nuclear deterrent forces, particularly, in the yield-to-weight ratio of warheads of the Minuteman and Polaris class. We probably have surrendered our superiority in this weight class and we know that our missile systems are at present vulnerable to nuclear attack. Additional nuclear tests are required to insure the effectiveness of this missile deterrent force--on which greatly increased reliance has been placed by recent major decisions.

The Soviets have conducted thirty-two tests of devices above one megaton since testing resumed in 1961. This is three and one-half times the number of U. S. detonations in this yield range in the same period and is three more of this class than we have tested in our entire history.

SEE CHANGE MAR 13, 63

In analyzing the Soviet shots, our data indicates that they cannot be interpreted in terms of U. S. technology. However, it can be concluded, from the Soviets' obvious interest and demonstrated success in the larger yield weapons, that the United States has certainly lost technological superiority in the ten to one hundred megaton class and probably has surrendered superiority in the one to ten megaton class.

While the yield-to-weight ratio of weapons is an important consideration in the economics and flexibility of missile systems, it is not the deciding factor in insuring a military deterrent force. The crucial factor is the assurance that the force can survive and carry out its mission in the face of possible defenses. We do not have this assurance because of the present vulnerability of our missile systems to nuclear attack. This applies not only to the reentry bodies but also to the base system, whose reaction to such weapons effects as electromagnetic pulse, earth shock, and communication disruption, cannot be ascertained and corrected without additional testing.

Not enough is known today to guarantee that a Minuteman complex will survive the effects of an electromagnetic pulse generated by a single nuclear explosion. We cannot be at all sure that the command and control communications vital for the Polaris fleet will survive. Available information is inadequate to insure that hardening of missile sites and command and control centers will be as effective as necessary. Reliable data are lacking for redesigning reentry vehicles which are all so vulnerable to nuclear attack that they would be unable, even if heavily decoyed, to penetrate a relatively crude AICBM system. To obtain all of these data, vital to the survival and penetration of our missile forces, we need weapons effects tests.

Our knowledge of the Russian tests is insufficient to enable us to assess the status of their understanding of these vulnerability problems. However, the Soviets may already know enough to exploit these possible weaknesses in our missile systems. It is known that the Soviet Union has carried out tests of greater sophistication than ours, which might well have provided the weapons effects data of the type we seek.

Regardless of how much the Soviets may already know, they may obtain much of the needed data under a test ban by clandestine testing below the levels of detection (see Appendix IV). Single low-yield tests, or at most a moderate series, might well be adequate to place the Soviet Union at an important advantage. Finally, they could prepare a large scale test program and accomplish it very rapidly after a combination of extensive prior planning and sudden abrogation of the ban, to confirm and exploit any weaknesses, which we, meanwhile, will have been unable to explore or correct.

The effective functioning of command and control communications has become even more vital to our deterrent forces with the adoption of the Prescribed Action Link. Disruption of essential command-control circuits by nuclear blackout could cripple elements of these forces. Communications blackout due to high altitude explosions has not been adequately tested since the 1958 TEAK test. In the meantime, many corrective measures have been taken. A new high altitude test may be required to ascertain the adequacy of these corrective measures. (See Appendix I)

In the light of the known and suspected vulnerabilities of our missile deterrent forces, the Committee was not able to assure itself that these forces will be able to make their planned contribution to the national security if a test ban is imposed. It seems essential to us that the weapons effects test program described in Appendix I be carried out.

## III. FUTURE DEVELOPMENTS WHICH MIGHT ALTER THE BALANCE OF POWER *

There are many conceivable developments in nuclear explosives technology which might produce important shifts in the balance of military power. Some of these developments are clearly foreseeable now; others are speculative and may, if practicable, apply to achievements a decade or more in the future. Undoubtedly many important new concepts remain to be discovered (Appendix II).

The understanding and discovery of new nuclear explosion effects, both on the natural environment and on man-made devices, have proceeded at an accelerating rate since the U. S. and U.S.S.R. resumed testing. It is most likely that further study and experimentation in this field will lead to very important advances in nuclear explosives technology. These will relate to much more effective methods of employment of nuclear explosions in order to enhance important effects-blackout, electromagnetic pulses, large neutron yields, for example--and also

* I subcribe to the statements made in this report with one major reservation. This reservation has to do with some statements made in Section III (FUTURE DEVELOPMENTS) and the supporting arguments in Appendix II. While the direction of the argument in these places is correct as I see it, I feel the statements are somewhat too optimistic as to what can be accomplished, for example,in the area of pure fusion weapons. However, I have no doubt that, with testing, important advances in weapon technology and, more so perhaps, in weapon applications will be made.

—— Conrad Longmire

to radical changes in nuclear explosives design to enhance specific effects, and to adapt them to new uses. New discoveries in these fields are expected to be far more important than the continued increases in yield-to-weight ratios.

[redacted] Either type of explosive will make it possible to equip tactical forces with large numbers of warheads with yields ranging down to those of conventional chemical explosives. These weapons will allow close support of ground troops without fear of fall-out. Such explosives will have a profound effect on tactical warfare, which would cause a major shift in the balance of military power if developed and exploited by only one country.

Similar clean and inexpensive devices could be used in SPRINT-type defensive missiles. The absence of beta decay products will reduce self-blackout for these missiles. Proper chemical composition may further reduce the period during which the fireball remains strongly ionized. In addition, the high output of fast neutrons provides an excellent kill mechanism against incoming warheads.

Several possibilities exist for achieving a high degree of energy directivity of nuclear explosions in space. Weapons which produce narrow cones of either high velocity vapor or high velocity particles seem feasible. Successful development of a concept employing either or both of these devices might lead to effective means for decoy discrimination and interception of ballistic missiles or their warheads at greatly extended ranges.

A large fraction of these new concepts could be investigated experimentally in detail by clandestine testing in the yield range below detection thresholds (Appendix IV).

## IV. MAINTAINING STRONG WEAPON LABORATORIES AND TEST READINESS UNDER A TEST BAN

We are not convinced that during a test ban, adequate budget and incentives would in fact be provided to preserve the U. S. capability and readiness to test. On the other hand, we foresee no significant problem for the totalitarian Soviet state to maintain weapons research and test preparedness.

At the time this country was considering the 1958 self-imposed nuclear test moratorium, serious concern was expressed regarding the probable decrease in proficiency of our weapon laboratories and the disintegration of our testing capability during an extended period of no testing. It was also predicted that during such a period the Russian effort would not slacken. Unfortunately, events of the past eighteen months have verified the correctness of these predictions.

Significant Soviet gains were demonstrated in their 1961 test series. These gains resulted from an accelerated and comprehensive Soviet nuclear weapons research and development program. The U. S. program of this period was one of declining interest in advanced weapon development with the growth of nuclear technology limited to minor extensions of proven designs.

[redacted] Since such experiments can be hidden easily (Appendix IV), it is prudent to assume that they will proceed in Russia. It will be a cause of intolerable asymmetry if the terms of the agreement forbid such experiments in the United States. It is vital for our program that these experiments should be fully encouraged by higher authority. Unless this is done, the Soviets will gain more from the loss of our momentum than they will realize from the acceleration of their own efforts.

It has been proposed that in the future Soviet advantages from a surprise abrogation can be reduced to an acceptable level by a national policy of maintaining strong weapon laboratories and test facilities readiness. After examining this proposal, as discussed in Appendix III, the Committee could not convince itself that the problem is much different today than it was in 1958.

## V. OPPORTUNITY FOR COVERT TESTS

The degree to which nuclear tests could be covertly conducted under a test ban treaty are discussed in Appendix IV. The developments which might result from such tests have been noted in the previous sections. Two facts are worthy of further emphasis withrespect to clandestine testing:

A. The U. S. S. R. can conduct extensive weapons development and weapons effects programs with covert tests below the levels of detection--underground, in the atmosphere, and in space.

B. While intelligence may reveal evidence of some covert tests, if they should be conducted, the treaty contains no provision to exploit such evidence by inspection--only seismic signals which permit epicentric location will suffice for inspection under the terms of the treaty which is now being negotiated. No recourse is provided in the event of space tests, short of withdrawal from the treaty.

## VI. RECOMMENDATION

We recommend that the Air Force make clear to higher authority the extent of the military risks inherent in a nuclear test ban.

## APPENDIX I

# SUMMARY OF FUTURE EFFECTS TEST REQUIREMENTS*

Report by the Twining Committee

to

The Chief of Staff, U. S. Air Force

4 March 1963

*Excerpts from a report submitted to DDR&E/OSD by W. G. McMillan, Chairman of DDR&E Ad Hoc Weapons Effects Group.

# APPENDIX I

## SUMMARY OF FUTURE EFFECTS TEST REQUIREMENTS*

### I. INTRODUCTION

The requirements for additional information on weapons effects and weapon systems vulnerabilities are indicated elsewhere in this report. In this Appendix a number of specific effects tests are proposed to respond to the most critical needs. Some of the proposed tests have already been reasonably well defined by various studies; some are even in an advanced stage of planning. Others can be only roughly characterized at this writing, and the detailed specifications of the test parameters must await further analysis.

Since budgetary, technical and political constraints may limit the rate of future nuclear testing, it is useful to classify each proposed test according to an evaluation of its degree of urgency and relevancy to U. S. military systems. The first priority includes those tests designed to remove critical uncertainties and possible defects in existing and programmed major weapon systems. Tests in second priority have as their primary purpose the provision of information essential to the planning of future weapon systems. There is a third category of tests which, though perhaps most important in the long run, have not been motivated up to this time, by immediate and pressing weapon systems requirements. These are the tests aimed at acquiring fundamental knowledge of the physics of weapons effects. A number of such tests have been proposed but are not included in this Appendix. However, we believe that if atmospheric testing resumes, at least some of these fundamental experiments should and will be carried out.

*The tests proposed in this Appendix were submitted to DDR&E/OSD by W. G. McMillan, Chairman of DDR&E Ad Hoc Weapons Effects Group. Inclusion of the proposal in this report is intended to indicate agreement and to add emphasis on the importance of an active, well-supported test program.

Since the political climate may permit--or even force--U. S. resumption of atmospheric tests in advance of present DOD planning dates, we have also felt it important to give at least a crude estimate of the time required to prepare the various tests. It is perhaps a worthwhile reminder that certain tests can provide very useful information on a short time scale, as was demonstrated in the PEAR (CHECKMATE) shot.

## II. FIRST PRIORITY TESTS

### A. PROOF TEST OF MINUTEMAN MISSILE SITES

Originally our hardest missile silos (MINUTEMAN) were designed to withstand an overpressure level of 100 psi, which was later reevaluated as 300 psi. While enough was known concerning air blast to design the silo door with fair confidence, relatively little was known about the kind of earth motions which result from surface nuclear bursts and the kind of earth motions which might damage a silo or its contents.

Although the electromagnetic pulse effect was known to exist, its relevance to missile-site vulnerability was not fully appreciated until called to our attention by British scientists. Even then, little could be done to thoroughly evaluate the danger because of the lack of close-in electromagnetic measurements. One near-in measurement on the PLUMBBOB PRISCILLA test, a 40 KT shot at an altitude of 700 feet on a tethered balloon over Nevada, indicated a disturbingly large, low frequency vertical component of the magnetic field. When extrapolated to yields of one megaton or greater, it appeared to represent a severe danger of rupturing communications and command cable loops in a missile complex. There was, and has continued to be, considerable disagreement on this effect due to the lack of any reliable theory, disagreement in the limited measurements, and lack of confidence in the extrapolations.

Although the need for a surface test in the megaton range was clearly recognized for the electromagnetic pulse effect and the blast and shock effects, this was not possible on the short time scale allowed

for preparing the U. S. 1962 test series. In addition to the time limitation, an appropriate site was not available with appropriate elements--silos, cable loops, control center, etc.

[redacted] While it was recognized that this test was incapable of giving the direct information applicable to a high yield shot, the yield was chosen as probably the largest politically acceptable for a surface test in Nevada.

[redacted] The Air Force has undertaken the design of such a test and will submit a proposal to the Director of Defense Research and Engineering for approval in late March 1963. Additionally, a joint working group, the RUFUS Committee, has been established under the aegis of the Lawrence Radiation Laboratory to select a suitable site.

These shots should be especially instrumented for effects of EMP and near-in earth shock. To assure that the proof tests give maximum information and to provide a sound theoretical basis for extrapolating to other conditions of yield, soil characteristics, bomb asymmetry, fusion vs fission, etc., several smaller yield exploratory shots will also be required. One such exploratory shot is a symmetrical explosion of a few kilotons over salt water, which provides a simple boundary condition for the EMP. [redacted]

Since ultimately we must depend upon theory to translate the results of a limited number of experiments into an over-all assessment of vulnerability, a full-time theoretical group should be established and assigned the responsibility for detailed specification, design and interpretation of these EMP experiments.

Table 1

MINUTEMAN PROOF TEST PROGRAM

| Purpose | Yield | Altitude | Conditions | Location | Lead Time(Mo) |
|---|---|---|---|---|---|
| [redacted] | | Surface | Over salt water | PPG | ~12 |
| | | " | " | | ~12 |
| | | " | | NTS? | ~12 |
| | | " | | Alaska? | ~24 |

## B. DEVELOPMENT AND TESTING OF HARDENED R/V's

1. X-RAYS--Above the atmosphere the x-rays from a nuclear explosion travel unimpeded to great distances. If these x-rays impinge on the surface of a reentry vehicle in sufficient intensity, their energy, deposited in a thin surface layer, causes an explosive vaporization which may damage the R/V structure and warhead.

In order to obtain more direct information on R/V's exposed to x-rays in space, an attempt was made to carry several R/V's on the STARFISH launcher and expose them to the bomb x-rays at predetermined distances. The failure of the first STARFISH vehicle, which disintegrated at ~40 Kft, has been ascribed to the fact that it carried a mixture of pods and R/V's. Subsequent STARFISH firings did not include R/V's; hence, this important part of the experiment was not accomplished.

STARFISH PRIME was successfully launched carrying three instrumentation pods which were designed to be spin-stabilized in order to expose numerous small samples of nose cone materials to the x-ray flux. Unfortunately, the pods were not well-oriented and gave little information of value on this effect.

[redacted]

As far as the problem of the vulnerability of actual R/V structures is concerned, however, we still require the exposure of full-scale vehicles to x-rays, followed by an evaluation of the resulting damage with respect to reentry. [redacted]

2. NEUTRONS--Another type of long-range damage to an R/V exposed to a nuclear blast is that which results from the fission heating produced by neutrons captured in the fissionable material. Depending upon the neutron flux, this heating may produce dimensional distortions, phase transitions, melting or even vaporization. Since there exist highly developed numerical codes for calculating neutron transport, this aspect of warhead vulnerability was thought to be calculable. [redacted]

Considerable effort is going into learning how to harden warheads to neutron effects. It seems probable that this knowledge will be needed in designing future reentry systems. [redacted]

[redacted] But this is just another example of how easy it is to overlook an essential point in the absence of experiments.

[redacted]

The absence of this critical information leaves an important gap in our understanding of missile vulnerability. The Air Force has been directed by the Secretary of Defense to plan and design a test to study this effect. This plan was submitted for approval in late February 1963. The program, originally directed exclusively toward the Mk 11 reentry system, has been reoriented to include the equally important measurements necessary to guide the Mk 11a and Mk 12 hardening programs now under study. Most important of all will be tests on hardened reentry systems, when they have been designed and built, to be sure that no significant vulnerabilities have been overlooked.

To develop hardened R/V's that can survive nuclear attack during reentry requires a capability--such as proposed in the Air Force SLEIGHRIDE program. Coupled with such proof tests on hardened vehicles is the need for some simpler preliminary tests to provide critical and timely information in the design stage of the hardened R/V's, specifically for the MINUTEMAN Mark 12 system, now authorized. One such preliminary test is to expose a hardened R/V to combined neutron and blast effects without reentry. At the relevant vulnerability distances for hardened vehicles the shock velocity is appreciable (compared with the reentry velocity); therefore, helpful information can be obtained in this way. [redacted]

Table 2

TESTS FOR R/V HARDENING

| Purpose | Yield | Altitude (km) | Conditions | Location | Lead Time (Mo.) |
|---|---|---|---|---|---|
| [redacted] | | ~10 | A/C or balloon | PPG | 6-8 |
| | | 10-20 | Variable standoff distances | See below | 18-24 |
| | | ~100 | " | " | 18-24 |

The most direct way of carrying out the reentry experiments is to launch from the continental U. S., as proposed in the SLEIGHRIDE program. The long lead time required to do this, however, makes it urgent to know that approval would be given for launching a warhead-carrying missile from the ZI when atmospheric testing is resumed. If the guarantee of such (conditional) approval cannot soon be achieved, an alternative plan would be made for launching from Johnston Island with the selection and development of an appropriate target area and down-range instrumentation. A second alternative could include launching non-nuclear R/V's from Vandenberg and intercepting with nuclear devices fired from Christmas or Johnston Island.

## C. REDUCING FIREBALL BLACKOUT

Altitudes below ~25 km may be of little interest for precursor bursts, since this already represents a fairly deep penetration. Such altitudes are of interest, however, for the ABM system itself, since intercepts would be made in this region. Although the fireball blackout

*It would be desirable also to have an underground x-ray experiment in which actual hardened R/V's could be exposed for study of structural response and integrity. [redacted]

produced by nuclear explosions below about 25 km is relatively localized, it is both intense and long-lived. Thus if the ABM system is faced with multiple warheads which must be attacked simultaneously, it may find it difficult to operate in the environment of multiple fireballs even though several radars are employed.

In understanding fireball blackout both the BLUEGILL and TIGHTROPE results are relevant, as are also some of the fireball measurements made on the weapons development drops at Christmas Island. Again this data is incompletely analyzed. The initial fireball dimensions in the relevant altitude regime are fairly well predictable from pure hydrodynamics. However, there does not yet exist the capability to calculate theoretically the subsequent hydrodynamic motion--especially the development of the toroidal cloud and the spatial distribution of the fission debris. Also, because of uncertainties in the air chemistry, the magnitude and duration of the fireball blackout cannot be accurately predicted.

[redacted]

Table 3

TESTS TO REDUCE FIREBALL BLACKOUT

| Purpose | Yield | Altitude (km) | Conditions | Location | Lead Time (Mo.) |
|---|---|---|---|---|---|
| [redacted] | | 10-20 | [redacted] | J. I. | ~ 12 |
| | | 10-20 | | " | ~ 12 |

## D. COMMUNICATIONS BLACKOUT

The importance of nuclear blackout on communications has been recognized since the TEAK event, which knocked out many communication links for hours. As a by-product of the present high altitude series, considerable additional information on this effect has been obtained. Within the range of our experience it may now be possible to make fair estimates of the extent and duration of such blackout, provided the explosion occurs at night. In daylight, photodetachment can play an important role, as we know, because the communications circuits knocked out by TEAK around midnight and re-established in the pre-dawn hours were knocked out again at sunrise. The blackout from a daytime shot--both radar and communications--might thus be far greater than for a corresponding nighttime event. It is a curious fact that all of the U. S. high-altitude shots have occurred in darkness, while all of the Soviet high-altitude shots have occurred in daylight.

To meet the operational demands for positive control in a nuclear environment, a large-scale high-altitude nuclear communications blackout test with full operational participation (SAC, NORAD, etc.) has been suggested. In order to examine and better define this requirement, an early review has been proposed, under the auspices of the DDR&E/OSD Ad Hoc Weapons Effects Group, of the communications systems and problems of the various operational commands. In this connection the Secretary of Defense has directed the Defense Communications Agency to make a comprehensive analysis of the vulnerability of the communications systems to blackout effects in case of large attack. [redacted] Such a test could probably be prepared in 6 to 8 months' time.

Table 4
TEST FOR COMMUNICATIONS BLACKOUT

| Purpose | Yield | Altitude(km) | Conditions | Location | Lead Time (Mo.) |
|---|---|---|---|---|---|
| [redacted] | | ~75 | Daytime | J.I. | 6-8 |

## III. SECOND PRIORITY TESTS

### A. BETA & GAMMA BLACKOUT

The best counter to a ballistic missile defense would probably be lightweight, realistic decoys. Considerable effort is going into developing such decoys, but since the problem is far from solved, we are forced to explore other penetration aids. One promising aid is radar blackout from nuclear explosions.

1. BETA BLACKOUT -- The usefulness of radar blackout as a penetration aid depends both upon the type of blackout and the type of defense. To be effective, the blackout must be sufficiently intense to cause serious attenuation at the radar frequencies of interest, last for the tens of seconds required for the follow-on R/V to penetrate below the minimum commitment altitude, and extend over such a large area as to blind all radars defending the target. For a comparatively slow-reacting system like Nike Zeus, which must commit at an (incoming-missile) altitude in excess of 200,000 ft., beta blackout may satisfy these conditions.

Although beta blackout may not be effective as a penetration aid against a quick-reacting defense, there is no evidence that the Russians are developing such a system; therefore, it seems desirable to have an operational capability for creating this type of blackout.

[redacted]

[redacted] (Again, the blackout will be enhanced by photodetachment if conducted during daylight.)

[redacted] However, if only one test were allowed for the purpose, we would recommend the 150 km shot since it appears (theoretically) more promising for the production of operational beta blackout. [redacted] Furthermore, such a shot could be used to demonstrate the daytime x-ray blackout of HF communications. This effect is of interest because theory indicates that in the daytime even a few tens of kilotons (of x-rays) produced at an altitude of a few thousand kilometers can influence HF communications for about half an hour over a large fraction of the earth's surface.

Table 5

TESTS TO PRODUCE BETA BLACKOUT

| Purpose | Yield | Altitude (km) | Conditions | Location | Lead Time (Mo.) |
|---|---|---|---|---|---|
| [redacted] | [redacted] | 150 | [redacted] | J. I. | 6-8 |
| | | 115 | | " | 6-8 |

2. GAMMA BLACKOUT--In part because of the difficulties posed by beta blackout, U. S. thinking with respect to possible ABM defenses has turned increasingly toward a quick-reacting system, perhaps involving a combination of phased-array radars and sprint missiles. Such a system appears capable of acquiring at altitudes as low as 25 or 30 km and still intercepting at a sufficiently high altitude to make a substantial reduction in ground damage, even assuming the incoming missile is sympathetically detonated. The possibility of such a quick-reacting system leads to the question of whether blackout can be produced at altitudes considerably below the 70 km beta-deposition layer. Theory indicates that such low-altitude blackout can be produced by gamma rays.

Preliminary analysis of the BLUEGILL data appears to confirm that the production of operationally significant gamma blackout is feasible. The signal from a rocket-borne kilomegacycle beacon transmitting (one way) through the gamma ionization layer at a lateral distance ~50 km from the burst point was attenuated some tens of db for a few seconds. The blackout can presumably be increased substantially by raising the (fission) yield, since the attenuation at a given time scales directly with yield. The BLUEGILL data incidentally confirm that photodetachment due to light from the fireball contributes to prolonging the blackout, especially within the upper portions of the ionized layer.

3. REDUCING GAMMA BLACKOUT--[redacted]

Table 6

TEST FOR THE REDUCTION OF GAMMA BLACKOUT

| Purpose | Yield | Altitude (km) | Conditions | Location | Lead Time (Mo.) |
|---|---|---|---|---|---|
| [redacted] | | 50 | [redacted] | J.I. | 6-8 |

## B. PROTECTIVE STRUCTURES

While the MINUTEMAN proof test discussed above would involve extensive earth-shock measurements, these would be for the most part pertinent to the relatively low hardness level for which the MINUTEMAN silos are designed and, therefore, would not be applicable to the problem of designing very hard command and control posts deep underground. [redacted] If these indications could be verified soon by experiment, superhard command and control centers could be built at considerably reduced depth and correspondingly reduced costs. Two tests are proposed. [redacted] Preparations for this experiment have been authorized by DDR&E and funds have been programmed. The second test would provide the missing connection between such tamped underground explosions and surface bursts. To this end, a hardened structure at a depth of several thousand feet, deep in granite, should be subjected to a large yield surface burst directly overhead. Conceivably this might be an adjunct of the MINUTEMAN proof test.

Table 7

PROTECTIVE STRUCTURES TEST PROGRAM

| Purpose | Yield [redacted] | Shot | Structures | Medium | Location | Lead Time (Mo.) |
|---|---|---|---|---|---|---|
| [redacted] | | | | Granite | NTS | ~12 |
| | | | | " | Same as EMP MM site? | ~18 |

[redacted] These tests will be ready by mid-1964.

## IV. LONG LEAD-TIME ITEMS

It seems possible that we might someday be forced to conduct a weapons effects test program on an arbitrarily imposed time scale. Our experience in the recent Pacific tests shows the importance of developing not only the measurement techniques specific to a given test, but also such general capabilities as launch and tracking facilities. We strongly urge that the present breathing space be used to:

* Refine tracking and relative position measurement of several simultaneous radar objects.

* Adapt the THOR vehicle to carry various types of R/V's and pods.

* Adapt solid propellant missile (e.g., Polaris, Sergeant booster, etc.,) as alternative launchers.

* Wed a spectrum of warheads to the various missiles.

* Eliminate unnecessary ballast and fuel; develop tankage separation.

* Provide a sufficient number of launching pads to handle maximum traffic.

* Extend permissible THOR launch azimuth, perhaps by the reversal of yaw and pitch controls.

* Requisition and procure instrumentation rockets, recently in critically short supply.

* Instrument three C-135 aircraft for airborne diagnostics. (The Air Force has been directed by the Secretary of Defense to provide these for AEC instrumentation.)

* Provide replacement aircraft for the samplers used in Operation DOMINIC. These aircraft are well beyond their designed life and are marginal in both altitude and range for the sampling mission.

Even though no definitive answer can yet be obtained on whether and when atmospheric testing will again be allowed, several critical decisions must be made immediately in order that preparation can go forward. These include:

* The siting of the MINUTEMAN proof test.

* The choice and authorization of the launch and impact locations for the dynamic reentry experiments.

* The authorization for the release and commitment of a substantial fraction of the total cost of the test series to provide for long lead-time procurement.

In the present political climate the U. S. must insure its ability to conduct nuclear weapons effects tests on short notice, even though the cost of such insurance may run to tens of millions of dollars.

APPENDIX II

# THE EXPANDING FRONTIER OF NUCLEAR TECHNOLOGY; REASONS SPECIAL TO THE UNITED STATES FOR MOVING PROMPTLY AHEAD

Report by the Twining Committee

to

The Chief of Staff, U. S. Air Force

4 March 1963

## APPENDIX II

## THE EXPANDING FRONTIER OF NUCLEAR TECHNOLOGY; REASONS SPECIAL TO THE UNITED STATES FOR MOVING PROMPTLY AHEAD

### I. WIDENING DIVERSITY OF NUCLEAR TECHNOLOGY

We have examined an argument sometimes advanced in connection with a nuclear test ban that "There is no new development in nuclear explosion technology for which the United States has vital need."

This claim, we are forced to conclude, rests on a complete misestimate both of the future of nuclear technology, and of the dangers--implicit in this technology--of our present nuclear position vis-a-vis the Soviets.

The technology has already outstripped that primitive measure of merit known as the "yield-to-weight ratio." This ratio is surely relevant to the destruction potential of a ballistic missile warhead. It is also the quantity most easily evaluated in a test, even by an observer at a distance. Therefore, it is not surprising that comparisons of U. S. and Soviet shots focus attention upon this yardstick of accomplishment. [redacted] Such a narrow view would look at Watt's engine pumping water out of a mine, compare its efficiency with the theoretical limit of so many pounds of water per pound of coal burned, and conclude that the steam engine could not much affect civilization!

Engine technology has grown in part through improvements in efficiency, but much more through widening applications. Similarly,

weapons technology today is concerned in part with the yield, but more with the effects of explosions. There is no one magic application on which attention can focus to the exclusion of everything else. Nothing makes more impression on one reviewing the new developments than the ever-widening diversity of nuclear technology.

## II. TACTICAL WEAPONS

[redacted] These weapons would greatly increase our options in tactical warfare by essentially closing the gap in the tactical firepower spectrum.

A. We would here quote from the Air Force SAB Strategic Concepts Ad Hoc Committee Report on Future Nuclear Weapons of December 1962.

"The cost of the fuel of these weapons will be small; their cost will be largely the fabrication cost.

"Some implications of such developments are: (1) Any nation which has a modern industrial capacity can make such weapons. There are many nations today with adequate capabilities and others can develop the capability. It is conceivable that others may be able to purchase such weapons. (2) [redacted]

[redacted] (3) The distinction between conventional weapons and nuclear weapons will tend to disappear. [redacted] These weapons will produce little or no radioactive fallout or debris. The basic concepts of personnel kill with small weapons will change from blast effects to neutron effects which will have little destructive impact on physical features of buildings, manufacturing facilities, etc. (4) Our present stockpile of weapons will be rendered obsolete. The fissile material could be made available for reactor or other uses. (5) [redacted] (6) The impact on limited warfare could be great. [redacted] (7) Since there is no known protection against fusion weapons, except for shielding and dispersal, limited warfare tactics will be greatly altered. Furthermore, it is probable that the balance of power with respect to limited warfare will rest with the nation which first perfects these weapons and produces them in large quantities.

[redacted]

If these ultimately inexpensive devices can be made at all--as seems likely--then second level nations can make them. If we do not keep the scientific leadership, others will take it. No responsible proponent of any detection system has claimed ability to detect a small pure hydrogen detonation underground.

If the United States is to renounce a revolutionary device which others can then secure without our knowledge, no portion of this responsibility should attach to the Air Force.

easy and certain. (3) The distinction between conventional weapons and nuclear weapons will tend to disappear. Once the technology is available fusion weapons can be made of any desired yield, very small as well as very large. These weapons will produce little or no radioactive fallout or debris. The basic concepts of personnel kill with small weapons will change from blast effects to neutron effects which will have little destructive impact on physical features of buildings, manufacturing facilities, etc. (4) Our present stockpile of weapons will be rendered obsolete. The fissile material could be made available for reactor or other uses. (5) These pure fusion weapons will have an important impact on strategic weapons because of their lack of vulnerability to neutron kill. (6) The impact on limited warfare could be great. The ultimate small size and low cost mean that they may be used in great quantities by ground armies and by tactical air forces. They could be used with all types of launchers perhaps even hand-fired weapons. (7) Since there is no known protection against fusion weapons, except for shielding and dispersal, limited warfare tactics will be greatly altered. Furthermore, it is probable that the balance of power with respect to limited warfare will rest with the nation which first perfects these weapons and produces them in large quantities."

B. A test ban will stop the active U. S. effort to develop a technology of pure hydrogen devices free of fission fallout. No one can exclude the possibility that in three to ten years such a technology will outdate present nuclear weapons and revolutionize ground warfare.

If these ultimately inexpensive devices can be made at all--as seems likely--then second level nations can make them. If we do not keep the scientific leadership, others will take it. No responsible proponent of any detection system has claimed ability to detect a small pure hydrogen detonation underground.

If the United States is to renounce a revolutionary device which others can then secure without our knowledge, no portion of this responsibility should attach to the Air Force.

## III. DIRECTED ENERGY

Possibilities exist for achieving a high degree of energy directivity of nuclear explosions in space. The most obvious applications are mid-course decoy discrimination of ICBM decoys, boost phase kill of ballistic missiles, and pre-terminal defense against missiles.

The concept is one of producing narrow cones of either high velocity vapor or high velocity solid particles which might intercept ballistic missiles or their warheads at greatly extended ranges from the intended target area. This work cannot be carried forward effectively without tests. However, important progress is possible at a level of underground testing which is below the threshold for detection.

## IV. SPACE PROPULSION

There is another area where preliminary exploitation is likewise possible with tests which are below the level of reliable detectability, and likewise impossible if all tests are banned: propulsion by nuclear explosives. This concept might make possible the transportation of payloads from a hundred tons to tens of thousands of tons. Among the uses one can visualize for such a propulsion system, the most obvious military application would be a detailed continuous surveillance of the earth's surface by a massive manned space vehicle.

The range of application of this principle of propulsion by explosive drive might be extended if pure fusion explosives become available. For then the "critical mass" is many orders of magnitude smaller than the critical mass for fissile material which triggers all present-day nuclear explosives.

## V. GEOPHYSICAL EFFECTS

The interaction of nuclear bursts with the natural environment is so poorly understood that we are not only unable to assess the effects of various things that could be done, we cannot even be sure of avoiding

inadvertent large scale effects. For example, the STARFISH shot temporarily modified the earth's magnetic field in an important and unexpected way. It should be noted that the total energy of the earth's magnetic field is comparable to 300 MT. Various combinations of high yields and directed electron beams have the potential for important effects that we only dimly perceive.

It also is likely that significant climatic effects could result from various acts that are already within the capabilities of our technology, such as blocking or enlarging marine canyons to alter ocean currents or triggering other sensitive climatic levers.

Since these new dimensions of effects are coming within the capacity of our technology, it is important that we increase our efforts to understand phenomenology and assess effects either with or without nuclear testing. Such a conclusion suggests both a need for increased general understanding of natural environmental processes and a need for a systematic assessment of the known and suspected natural levers that could be affected by man-made events.

## VI. CONCLUSIONS

The technology of nuclear energy has its own laws and its own internal structure. It can be stopped by the hand of man as little as the advance of weaving machinery could be stopped by the Luddite mobs. But we can be stopped by our own actions. Out of a developing nuclear technology, we see emerging better defense and peaceful uses of nuclear energy. But the most important peacetime use of nuclear energy is the preservation of the peace.

## APPENDIX III

# PROBLEMS OF MAINTAINING STRONG WEAPONS LABORATORIES AND TEST READINESS DURING A TEST BAN

Report by the Twining Committee

to

The Chief of Staff, U. S. Air Force

4 March 1963

# APPENDIX III

## PROBLEMS OF MAINTAINING STRONG WEAPONS LABORATORIES AND TEST READINESS DURING A TEST BAN

### I. INTRODUCTION

The sudden breaking of the 1958 moratorium after extensive clandestine preparations enabled the Soviets to approach equality, perhaps even achieve superiority, to the U. S. in weapons effects knowledge and weapons development. To avoid a similar repetition of this serious military setback, the U. S. Arms Control and Disarmament Agency has stated the intention of maintaining during a test ban a continued preparedness to test by providing adequate incentives to weapon scientists and adequate budgets to maintain operational readiness.

"Maintaining readiness" infers that our current weapons laboratories and testing capability are at least on a par with those of the U.S.S.R. This is highly questionable.

There is reliable information that the Soviet weapons laboratories and nuclear testing facilities underwent major expansion during the 1958-1961 moratorium; U. S. laboratories lost momentum and our testing capability was intentionally disintegrated.

An analysis of the 1961 and 1962 series of Soviet tests show them to be the most extensive and complex in the history of nuclear testing. They not only demonstrated a "highly sophisticated nuclear weapons technology" [redacted] but exercised complete weapons systems, including both ground and naval launched ballistic missiles, surface-to-air missiles and underwater naval weapons. The Soviets also conducted very sophisticated high altitude effects shots in conjunction with their ballistic missile facilities at Kapustan Yar and their AICBM installations at Sary Shagan.

The current United States capability in our weapons laboratories, Task Force 8, and limited testing facilities will not permit us to approach the complexity or rate of the Soviet 1961-1962 testing without at least 18 months of comprehensive planning, preparations, and buildup.

## II. MAINTAINING STRONG WEAPONS LABORATORIES

The Committee attempted to establish the nature of the incentives and the likelihood of the continued budget support which could, with reasonable assurance during a test ban, build up and maintain U. S. readiness to test at a rate already achieved and demonstrated by the Russians. So far as incentives are concerned--money, patriotism, scientific challenge and prestige were explored.

Money appeared to be a far-from-adequate incentive. The most competent scientists have consistently traded monetary reward for freedom of research and the right to work on what they believe to be the most important and challenging problems. There is no question that even today, in the face of urgent problems bearing on U. S. national security, the majority of our best scientists are in universities at reduced salaries spending only a fraction of their time on problems of national security.

So far as patriotism is concerned, it is difficult to see how it could be a compelling incentive to work on weapons in the face of a Government-sponsored moratorium. The very fact of a test ban and the many past statements by Government spokesmen questioning the importance of weapons testing and weapons development as compared with other areas of national security would lead our competent scientists to believe that our national security would best be served in other areas.

In the absence of testing, it would be difficult to justify weapons development as a scientific challenge. Without experiments to verify or demonstrate the validity of a new scientific theory or concept, which is the very essence of the scientific method, a competent scientist could not long continue to feel that his efforts were meaningful.

Without means to demonstrate that his ideas were meaningful and right, the most important form of prestige, that of recognition of the correctness of his ideas, would be denied.

The only incentive which the Committee could foresee as adequate to retain the country's competent weapons scientists was the opportunity for experimental work--weapons tests. In a nuclear weapons laboratory about one-half the scientific competence is devoted to understanding the transport of energy from the primary of a nuclear device to its secondary. [redacted]

## III. MAINTAINING TEST READINESS

In examining the second part of the proposal of the U. S. Arms Control and Disarmament Agency--to provide adequate budgetary support to maintain operational test readiness--the Committee notes that the Executive Branch cannot guarantee a decision on budget, which fundamentally resides with the Legislative Branch. Moreover, even if the Executive Branch could persuade its contemporary Congress of the need for such support, both the Administration and the Congress will change with time and the continuity of adequate budgetary support would be threatened. The competition for the limited defense funds by seemingly greater urgencies and emergencies would inevitably corrode the resolve to maintain a standby test readiness of the necessary magnitude. The prospect of heavy investment in large test facilities (e.g., like the simulated MINUTEMAN complex required for a proof test, or the SLEIGHRIDE launch, tracking and intercept facilities) having less-than-certain probability of being used, is bound to generate severe objections. With each subsequent year, the large budgetary request demanded for replacement of instrumentation and necessary updating in the light of new systems developments will become increasingly hard to defend against drives for economy. Therefore, it seems most unlikely that the necessary state of test readiness could long be maintained under a test ban.

As a final point, the policy enunciated by the U. S. Arms Control and Disarmament Agency does not reckon with one of the most severe

difficulties encountered in the recently concluded U. S. Pacific test series, namely, the location and reassembly of experienced test technicians. Over the objections of many people concerned with the advance of nuclear weapons technology, Joint Task Force 7 was completely disbanded during the past moratorium. By the time Joint Task Force 8 was authorized, the experienced test personnel had become widely diffused throughout industry and the military services, and it was only at the cost of great effort and delay that key people could be reassembled.

In summary, the Committee could not convince itself that during a test ban, adequate budget and incentives could be provided to build up and preserve the U. S. capability and readiness to test. On the other hand, it foresaw no significant problem for the totalitarian Soviet state to maintain weapons research and test preparedness.

## APPENDIX IV

# THE OPPORTUNITY FOR COVERT ACTION UNDER A NUCLEAR TEST BAN

Report by the Twining Committee

to

The Chief of Staff, U.S. Air Force

4 March 1963

# APPENDIX IV

# THE OPPORTUNITY FOR COVERT ACTION UNDER A NUCLEAR TEST BAN

## I. INTRODUCTION

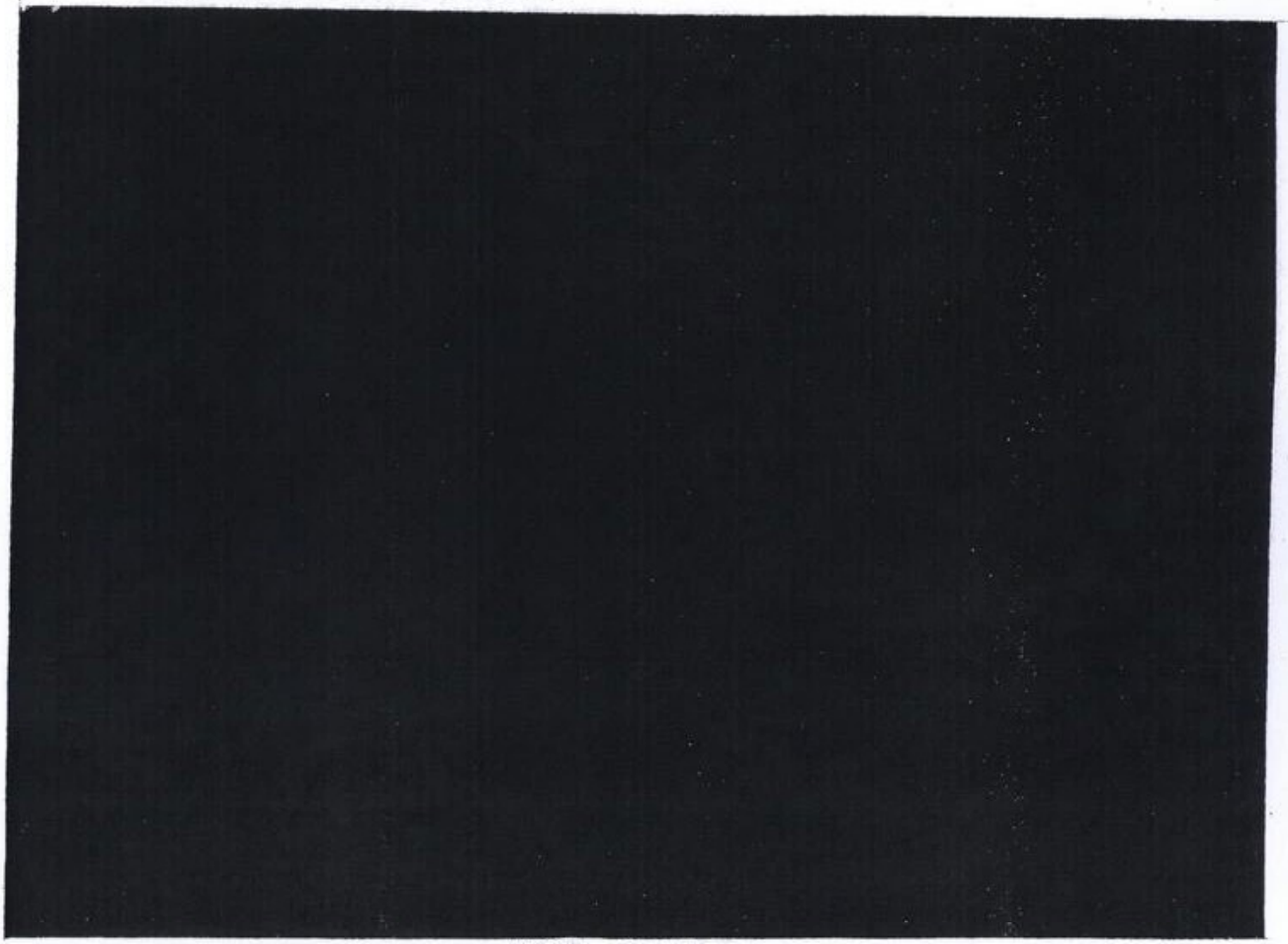
United States national policy has consistently demanded that any test ban agreement with the Soviet Union should be adequately controlled in order to assure Soviet compliance. The vital importance of this principle of control was demonstrated by the clandestine Soviet test preparations carried out under cover of the 1958 moratorium and which resulted in the Soviet breaking of the moratorium with their extensive and highly coordinated 1961 test series. These Soviet actions together with their recent 1962 test series show a very determined Soviet desire to achieve nuclear superiority over the U.S. in all aspects of nuclear weapons technology--superiority in efficiency and variety of nuclear weapons and superiority in knowledge of weapons effects. It is critical therefore to know the opportunities which a test ban agreement could afford the Soviets to pursue clandestinely their goal of superiority while the U.S. adheres to a test ban. The following discussion describes the nature of the nuclear tests which the Soviets might conduct without detection under a test ban agreement and points out some of the obvious gains which they could achieve through such tests.

In the event of a test ban agreement between the United States and the Soviet Union, the U. S. will place heavy--and perhaps total--reliance on a control system entirely outside Communist territory in order to monitor Soviet compliance. The capability of such a control system will be substantially the same as the current U.S. National Atomic Energy Detection System (AEDS), although some modest improvements in the capability might be expected after a few years of continued research under Project VELA.

## II. ESTIMATED DETECTION CAPABILITIES

AFTAC has made estimates of the present capability of the AEDS for detecting Soviet tests conducted underground, in the atmosphere, and in near space. For unshielded shots at high altitudes and in deep space, and for the same when shielded, estimates of U. S. detection capability have been made from information contained in the report and minutes of the Technical Working Group #1 of the Geneva Test Ban Conference. These estimates for detecting tests in all environments are presented in Figure 1.

### A. UNDERGROUND TESTS



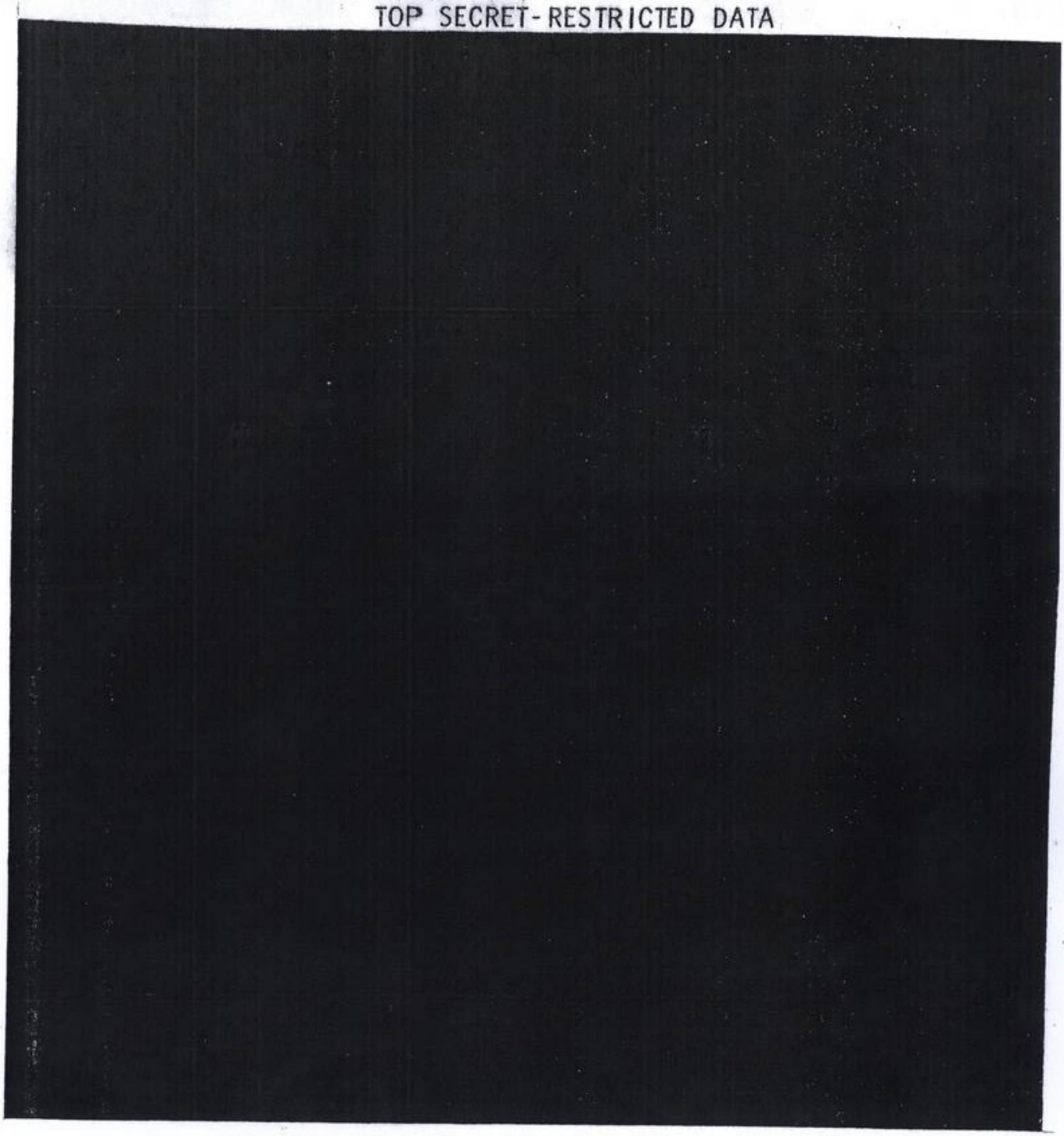


Fig. 1 - Theoretical Estimates of Limits of Detection of Nuclear Explosions Underground in the Atmosphere and in Space

B. ATMOSPHERIC TESTS

[redacted]

C. HIGH ALTITUDE TESTS

[redacted]

D. SPACE EXPLOSIONS

[redacted]

## III. UNCERTAINTIES

[redacted]

There are significant differences of opinion about whether the Soviets would risk clandestine testing for fear of discovery by non-technical means and whether there is significant value to such clandestine tests.

The extent to which fear of discovery by non-technical means will deter the Soviets from undertaking clandestine testing depends strongly on the nature of the non-technical information and the use to which it can be put. In general, the type of non-technical information which might be obtained will be insufficient to prove that a clandestine test has been undertaken; at most, it might raise some suspicion. For example, visual observation of surface depressions produced by underground explosions in alluvium or visual observations of construction which might be associated with a large underground cavity or an unannounced launching of a satellite or space probe.

In none of these cases is the information adequate proof of violation. In the first two, inspection at the site of the suspected violation might provide proof of a clandestine test, but such inspection would not be allowed under a test ban agreement. In the case of a satellite or space probe launching, it is not even clear that suspicion is justified.

## IV. POSSIBLE GAINS FROM COVERT ACTION

The risk of discovery by technical means will be weighed by a violator in relation to the value of such tests. [redacted]

[redacted] So far as weapons effects are concerned, re-entry vehicle vulnerability to X-ray and nuclear radiations can be studied and methods of hardening against these radiations can be developed. Moreover, limited studies of blast vulnerability of re-entry vehicles can be made. Considerable information can be obtained on the vulnerability of hardened missile sites and command and control centers to ground shock.

[redacted] Gamma ray and fireball blackout could probably be adequately, if not completely, studied. [redacted]

Some weapons effects information could probably not be obtained by clandestine tests alone, particularly full scale proof tests of system vulnerabilities. However, extensive theoretical analysis plus novel experimental techniques combined with clandestine testing might be sufficient to answer all important questions on weapons effects. For those tests vital to Soviet interests which could not be conducted clandestinely, it might be expected that the Soviets would resort to their earlier technique--preparation during the period of the test ban followed by sudden abrogation and an extensive, coordinated test series.

## APPENDIX V

# MILITARY IMPLICATIONS OF U.S. AND SOVIET NUCLEAR TESTING

Interim Report by the Twining Committee

to

The Chief of Staff, U. S. Air Force

12 December 1962

12 December 1962

General Curtis E. LeMay
Chief of Staff
United States Air Force
Washington 25, D. C.

Dear General LeMay:

On 20 August you requested the committee which reviewed the military implications of the 1961 Soviet nuclear test series to re-convene to up-date its report of 5 January 1962.

The committee has made an assessment of related subsequent actions of both the United States and the U. S. S. R. and wishes to submit the attached interim report. A final report will be submitted within the next sixty days.

Sincerely yours,

N. F. Twining

N. F. TWINING
General, USAF (Ret.)
Chairman of the Committee

Members of the Committee

J. H. Doolittle, Lt Gen, USAF (Ret)
Dr John S. Foster, Jr.
Prof David T. Griggs
*Dr Conrad Longmire
Dr Gerald M. McDonnel
E. E. Partridge, Gen, USAF (Ret)
*Dr Simon Ramo
Dr Theodore B. Taylor
Dr Edward Teller
Dr Stanislaw M. Ulam
Prof John A. Wheeler

*Unable to participate in the meeting of 8-11 Dec 1962, in which this interim report was prepared.

JOHN A. WHEELER By O.P.Thorn

## NEW OBSERVATIONS SINCE THE JANUARY 5, 1962 REPORT OF THE TWINING COMMITTEE

1. Soviet Accomplishments:

a. In both the 1961 and 1962 Russian test series, explosions in the multi-megaton range were emphasized, while at the same time tests in all observable ranges were performed. [redacted]

b. Many of the Soviet 1962 tests appear to be tests of operational multi-megaton missile warheads and bombs, including extensive participation by military forces.

c. There is reliable information that Soviet facilities for the production of both U235 and Pu239 have been steadily expanding and that they are being substantially increased at present.

d. There is reliable information that Soviet weapons laboratories underwent major expansion during 1958-1961 and that they are now operating at full capacity.

e. There is evidence which might indicate Soviet preparations for future testing of nuclear devices.

2. U. S. Accomplishments:

[redacted]



d. The low yield test, performed in 1962, designed to help determine the vulnerability of the MINUTEMAN launching complexes to nearby bursts in the megaton range, provided inadequate data for this determination.

e. The STARFISH space test did not produce the blackout effects which had been anticipated, and many of the observed phenomena associated with the explosion are not understood. This test has displayed our state of ignorance of effects of nuclear explosions in space.

f. It has become clear that directional nuclear explosives can be made. Such explosives might be effective for use in defense against ballistic missiles.

g. During the last year and a half the U. S. has developed an adequate capability to perform underground experiments and has made progress in the development of the capability to conduct high altitude effect experiments and air drop tests of advanced warheads.

## OVER-ALL COMPARISON OF DEVELOPMENTS

3. The fact stands out that in recent years the Russian rate of progress in the development of very high yield weapons, and in the conduct of exceedingly complex system and effects tests has substantially exceeded our own. Since 1961 they have performed many more observable atmospheric tests than the U. S. The difference in the rate of development is, in part, a consequence of the different procedures followed by the U. S. and the U. S. S. R. during the moratorium. This is illustrated by

the following table:

| U.S. | U.S.S.R. |
|---|---|
| Interest in advanced weapon development declined. | A large new weapon laboratory was constructed and put into operation. |
| *Key weapon design personnel worked on test ban treaty, and spent extended time in Geneva. Large efforts were expended by weapons laboratories in detection and inspection problems. | No weapons laboratory people were at Geneva; there was no evidence of participation by weapons laboratories in test ban considerations or in detection efforts. |
| Task Force 7 was disbanded at completion of 1958 program. | Preparation was made for logistic support of the most extensive nuclear tests ever conducted. |
| No specific plans or preparations for new weapons testing were made. | New weapons were designed, fabricated, and prepared for tests. |
| No high-yield weapons designs were actively under consideration. | Very high yield weapons were designed and prepared for test with such confidence that Khrushchev could allude to a 100 MT weapon in January 1960 and could advertise its debut at the beginning of the test series. |
| Arguments were advanced against effective missile defense. No experiments were planned. | Missile defenses were planned and effective test procedures were initiated. |

4. From a review of the U. S. and Soviet actions during the nuclear weapons test moratorium, and a comparison of their respective nuclear weapons programs, it is clear that:

*Dr. Ulam disassociated himself with this observation.

a. The Soviets have a high priority and purposeful program which goes ahead regardless of nuclear test ban discussions. This program is one of depth and breadth. It includes the expansion of laboratories and testing and production facilities. The Soviets have ballistic missile ranges for live testing of weapons and investigation of offense-defense interactions, and an atmospheric test range for high yield weapons. Their program also includes weapons development, effects research, and operational testing of complete systems on a continuing and orderly basis.

b. The rate of progress of Soviet nuclear technology is greater than our own. The over-all balance as of today may be close, but the present trend is definitely unfavorable. Our own rate of progress has been retarded by the uncertainties which have accompanied our programs ever since the adoption of the moratorium in 1958. The uncertainties have had the following debilitating effects:

(1) Momentum, continuity, and quality of planning have been degraded;

(2) Recruitment and retention of highly qualified scientists and engineers have been difficult;

(3) Motivation and inspiration of personnel have suffered;

(4) The timely allocation of adequate resources has been impossible;

(5) The number and types of tests conducted have been circumscribed by various constraints; and

(6) Execution of tests, when finally approved, has suffered from lack of adequate preparation.

c. The most fundamental requirement which must be met, if we are not to surrender superiority in nuclear technology to the U.S.S.R., is the establishment of a positive U.S. policy for a vigorous nuclear weapons development and weapons effect program, with testing as

required. Because of the interaction of nuclear technology with other military technologies, the present trend, if not changed, will lead to an imbalance of both offensive and defensive military capabilities decisively favorable to the U.S.S.R. It is difficult to visualize an effective U. S. strategy under such circumstances.

## RECOMMENDED ACTION

5. There remain many possible technological advances in the design of nuclear weapons and the utilization of weapon effects that could have a major bearing on the balance of power. [redacted] Among these could be presently unknown effects relating to missile defense and penetration of these defenses. The committee wishes to restate its belief that we cannot afford to let the Soviets retain the initiative in pursuing such objectives while we continue to be "reactive."

6. Specifically, we make the following recommendations:

a. On a high priority basis we should reestablish a long range, well planned weapons research, development and testing program and a vigorous, systematic weapons effects analysis and testing program.

b. Underground testing should be continued. As this type of testing is easily planned and creates the least disruption of other activities near the test site, it should be used when effective. Above ground tests should be performed when a clear-cut necessity for such tests exists.

c. We recommend that a fully instrumented site for large scale atmospheric testing be established and maintained.

d. There are several important experiments involving atmospheric tests that can profitably be accomplished as early as the latter part of 1963 and these should be done. These include:

[redacted]

(2) [redacted] Preliminary tests can best be done by dropping such re-entry vehicles (TIMPANI devices) simultaneously with a live warhead from a B-52 at high altitude.

(3) Further high altitude effects experiments to resolve some of the major uncertainties relating to ballistic missile defense by comparing the results of clean and standard explosions of the same yield at the same altitude. The clean explosives developed during the last year now permit us to separate those effects which are due to fission in a manner which could not be obtained in the last series.

(4) Nuclear experiments conducted in deep space ($10^5$ - $10^6$ Km) can be used to perform experiments important both to scientific research and the development of high yield nuclear warheads. The early firing of a low yield warhead is important to the development of diagnostic techniques and understanding of space nuclear explosion phenomena.

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# APPENDIX VI

## MEMBERS AND PARTICIPANTS

### MEMBERS

Lt Gen J. H. Doolittle, USAF(Ret)
Chairman of the Board
Space Technology Laboratories

Dr. John S. Foster, Jr.
University of California
Lawrence Radiation Laboratory

Prof. David T. Griggs
Institute of Geophysics
University of California

Dr. Conrad Longmire
Theoretical Division
Los Alamos Scientific Laboratory

Dr. Gerald M. McDonnel
University of California at
Los Angeles Medical Center

Gen E. E. Partridge, USAF (Ret)
Lockheed Aircraft Corporation

Dr. Simon Ramo
Executive Vice President
Thompson Ramo-Wooldridge, Inc.

Dr. Theodore B. Taylor
Senior Research Advisor
General Atomics Division
General Dynamics Corporation

Dr. Edward Teller
University of California

Gen N. F. Twining, USAF (Ret)
Chairman of the Committee

Dr. Stanislaw M. Ulam
Los Alamos Scientific Laboratory

Prof. John A. Wheeler
Palmer Physical Laboratory
Princeton University

### RAND CORP. PARTICIPANTS

Dr. Albert L. Latter
Dr. Richard Latter
Dr. William G. McMillan

DOD PARTICIPANTS

Dr. Gerald W. Johnson
Assistant to the Secretary
(Atomic Energy)

MILITARY PARTICIPANTS

Maj Gen Robert A. Breitweiser
Assistant Chief of Staff,
Intelligence, Hq USAF

Maj Gen William B. Keese
Deputy Chief of Staff/Plans
Air Force Systems Command

Maj Gen Seth J. McKee
Director of Plans
Strategic Air Command

Maj Gen Jerry D. Page
Deputy Director of Plans
for Aerospace Plans, Hq USAF

Maj Gen James F. Whisenand
Assistant DCS/Research and
Development, Hq USAF

MILITARY PARTICIPANTS (cont)

Brig Gen Glenn A. Kent
ODDR&E

Colonel Joseph O. Fletcher
Directorate of Plans
Hq USAF

Colonel Ola P. Thorne
Assistant for Nuclear Energy
DCS/Research and Development
Hq USAF

SECRETARIAT

Lt Col Kent P. Howard
Scientific Advisory Board, USAF

~~TOP SECRET~~

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# MILITARY IMPLICATIONS OF U. S. AND SOVIET NUCLEAR TESTING

Report by the Twining Committee

to

The Chief of Staff, U. S. Air Force

4 March 1963

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CONFIDENTIAL

4 March 1963

General Curtis E. LeMay
Chief of Staff
United States Air Force
Washington 25, D. C.

Dear General LeMay:

In response to your request of 20 August 1962, the Committee was reconvened to review the military implications of the 1962 U. S. and Soviet nuclear test series.

The Committee has completed its study and wishes to submit the attached final report.

Sincerely yours,

N. F. Twining

N. F. TWINING
General, USAF (Ret.)
Chairman of the Committee

Committee Member Concurrence

Dr. Simon Ramo
Dr. Theodore B. Taylor
Lt. Gen. J. H. Doolittle, USAF (Ret.)
Dr. John S. Foster, Jr.
Prof. David T. Griggs
*Dr. Conrad Longmire
Dr. Gerald M. McDonnel
Gen. E. E. Partridge, USAF (Ret.)
Dr. Edward Teller
Dr. Stanislaw M. Ulam
Prof. John A. Wheeler

Simon Ramo
Theodore B. Taylor
J. H. Doolittle
John S. Foster, Jr.
David T. Griggs
Conrad L. Longmire
Gerald M. McDonnel
E. E. Partridge
Edward Teller
S. M. ULAM - By PHONE
John A. Wheeler

*See footnote on Page 4.

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# MILITARY IMPLICATIONS OF NUCLEAR TESTING

## I. INTRODUCTION

SEE CHAN.

In a preliminary report of 12 December 1962 (Appendix V), this Committee reviewed the evidence from Soviet and U. S. nuclear tests and recommended the establishment of a long-range, vigorous nuclear weapons development and effects program. Since that time negotiations for a test ban treaty have resumed, and the positions of the U. S. and U.S.S.R. have become sufficiently close so that a treaty agreement soon may be reached. Moreover, in this interval additional restrictions have been imposed on U. S. testing. Because of these developments, the Committee has focused its attention in this report on the military implications of the test ban.

Official recent statements have placed considerable emphasis on three premises to support the desirability of a test ban.

A. The U. S. holds a nuclear lead and is most likely to maintain it if there is a test ban treaty.

B. Nuclear technology has reached a point of diminishing returns and under a test ban no developments are likely to occur that can upset the balance of power.

C. The risks of a surprise abrogation can be reduced to an acceptable level by a national policy of maintaining strong weapons laboratories and test facility readiness.

The Committee examined these premises from a scientific and military viewpoint and concludes that they are not valid. A test ban would involve greater risks to the national security than perhaps have been realized. An attempt is made to explore these risks so that they may be weighed against the presumed advantages.

## II. MISSILE DETERRENT EFFECTIVENESS

SEE CHANGE MAR 13, 1963

We disagree with the first premise. The belief in a United States nuclear lead is based, in great part, on an assumed superiority of our nuclear deterrent forces, particularly, in the yield-to-weight ratio of warheads of the Minuteman and Polaris class. We probably have surrendered our superiority in this weight class and we know that our missile systems are at present vulnerable to nuclear attack. Additional nuclear tests are required to insure the effectiveness of this missile deterrent force--on which greatly increased reliance has been placed by recent major decisions.

The Soviets have conducted thirty-two tests of devices above one megaton since testing resumed in 1961. This is three and one-half times the number of U. S. detonations in this yield range in the same period and is three more of this class than we have tested in our entire history.

SEE CHANGE MAR 13, 63

In analyzing the Soviet shots, our data indicates that they cannot be interpreted in terms of U. S. technology. However, it can be concluded, from the Soviets' obvious interest and demonstrated success in the larger yield weapons, that the United States has certainly lost technological superiority in the ten to one hundred megaton class and probably has surrendered superiority in the one to ten megaton class.

While the yield-to-weight ratio of weapons is an important consideration in the economics and flexibility of missile systems, it is not the deciding factor in insuring a military deterrent force. The crucial factor is the assurance that the force can survive and carry out its mission in the face of possible defenses. We do not have this assurance because of the present vulnerability of our missile systems to nuclear attack. This applies not only to the reentry bodies but also to the base system, whose reaction to such weapons effects as electromagnetic pulse, earth shock, and communication disruption, cannot be ascertained and corrected without additional testing.

Not enough is known today to guarantee that a Minuteman complex will survive the effects of an electromagnetic pulse generated by a single nuclear explosion. We cannot be at all sure that the command and control communications vital for the Polaris fleet will survive. Available information is inadequate to insure that hardening of missile sites and command and control centers will be as effective as necessary. Reliable data are lacking for redesigning reentry vehicles which are all so vulnerable to nuclear attack that they would be unable, even if heavily decoyed, to penetrate a relatively crude AICBM system. To obtain all of these data, vital to the survival and penetration of our missile forces, we need weapons effects tests.

Our knowledge of the Russian tests is insufficient to enable us to assess the status of their understanding of these vulnerability problems. However, the Soviets may already know enough to exploit these possible weaknesses in our missile systems. It is known that the Soviet Union has carried out tests of greater sophistication than ours, which might well have provided the weapons effects data of the type we seek.

Regardless of how much the Soviets may already know, they may obtain much of the needed data under a test ban by clandestine testing below the levels of detection (see Appendix IV). Single low-yield tests, or at most a moderate series, might well be adequate to place the Soviet Union at an important advantage. Finally, they could prepare a large scale test program and accomplish it very rapidly after a combination of extensive prior planning and sudden abrogation of the ban, to confirm and exploit any weaknesses, which we, meanwhile, will have been unable to explore or correct.

The effective functioning of command and control communications has become even more vital to our deterrent forces with the adoption of the Prescribed Action Link. Disruption of essential command-control circuits by nuclear blackout could cripple elements of these forces. Communications blackout due to high altitude explosions has not been adequately tested since the 1958 TEAK test. In the meantime, many corrective measures have been taken. A new high altitude test may be required to ascertain the adequacy of these corrective measures. (See Appendix I)

In the light of the known and suspected vulnerabilities of our missile deterrent forces, the Committee was not able to assure itself that these forces will be able to make their planned contribution to the national security if a test ban is imposed. It seems essential to us that the weapons effects test program described in Appendix I be carried out.

## III. FUTURE DEVELOPMENTS WHICH MIGHT ALTER THE BALANCE OF POWER *

There are many conceivable developments in nuclear explosives technology which might produce important shifts in the balance of military power. Some of these developments are clearly foreseeable now; others are speculative and may, if practicable, apply to achievements a decade or more in the future. Undoubtedly many important new concepts remain to be discovered (Appendix II).

The understanding and discovery of new nuclear explosion effects, both on the natural environment and on man-made devices, have proceeded at an accelerating rate since the U. S. and U.S.S.R. resumed testing. It is most likely that further study and experimentation in this field will lead to very important advances in nuclear explosives technology. These will relate to much more effective methods of employment of nuclear explosions in order to enhance important effects-blackout, electromagnetic pulses, large neutron yields, for example--and also

* I subcribe to the statements made in this report with one major reservation. This reservation has to do with some statements made in Section III (FUTURE DEVELOPMENTS) and the supporting arguments in Appendix II. While the direction of the argument in these places is correct as I see it, I feel the statements are somewhat too optimistic as to what can be accomplished, for example, in the area of pure fusion weapons. However, I have no doubt that, with testing, important advances in weapon technology and, more so perhaps, in weapon applications will be made.

—— Conrad Longmire

to radical changes in nuclear explosives design to enhance specific effects, and to adapt them to new uses. New discoveries in these fields are expected to be far more important than the continued increases in yield-to-weight ratios.

[redacted] Either type of explosive will make it possible to equip tactical forces with large numbers of warheads with yields ranging down to those of conventional chemical explosives. These weapons will allow close support of ground troops without fear of fallout. Such explosives will have a profound effect on tactical warfare, which would cause a major shift in the balance of military power if developed and exploited by only one country.

Similar clean and inexpensive devices could be used in SPRINT-type defensive missiles. The absence of beta decay products will reduce self-blackout for these missiles. Proper chemical composition may further reduce the period during which the fireball remains strongly ionized. In addition, the high output of fast neutrons provides an excellent kill mechanism against incoming warheads.

Several possibilities exist for achieving a high degree of energy directivity of nuclear explosions in space. Weapons which produce narrow cones of either high velocity vapor or high velocity particles seem feasible. Successful development of a concept employing either or both of these devices might lead to effective means for decoy discrimination and interception of ballistic missiles or their warheads at greatly extended ranges.

A large fraction of these new concepts could be investigated experimentally in detail by clandestine testing in the yield range below detection thresholds (Appendix IV).

## IV. MAINTAINING STRONG WEAPON LABORATORIES AND TEST READINESS UNDER A TEST BAN

We are not convinced that during a test ban, adequate budget and incentives would in fact be provided to preserve the U. S. capability and readiness to test. On the other hand, we foresee no significant problem for the totalitarian Soviet state to maintain weapons research and test preparedness.

At the time this country was considering the 1958 self-imposed nuclear test moratorium, serious concern was expressed regarding the probable decrease in proficiency of our weapon laboratories and the disintegration of our testing capability during an extended period of no testing. It was also predicted that during such a period the Russian effort would not slacken. Unfortunately, events of the past eighteen months have verified the correctness of these predictions.

Significant Soviet gains were demonstrated in their 1961 test series. These gains resulted from an accelerated and comprehensive Soviet nuclear weapons research and development program. The U. S. program of this period was one of declining interest in advanced weapon development with the growth of nuclear technology limited to minor extensions of proven designs.

[redacted] Since such experiments can be hidden easily (Appendix IV), it is prudent to assume that they will proceed in Russia. It will be a cause of intolerable asymmetry if the terms of the agreement forbid such experiments in the United States. It is vital for our program that these experiments should be fully encouraged by higher authority. Unless this is done, the Soviets will gain more from the loss of our momentum than they will realize from the acceleration of their own efforts.

It has been proposed that in the future Soviet advantages from a surprise abrogation can be reduced to an acceptable level by a national policy of maintaining strong weapon laboratories and test facilities readiness. After examining this proposal, as discussed in Appendix III, the Committee could not convince itself that the problem is much different today than it was in 1958.

## V. OPPORTUNITY FOR COVERT TESTS

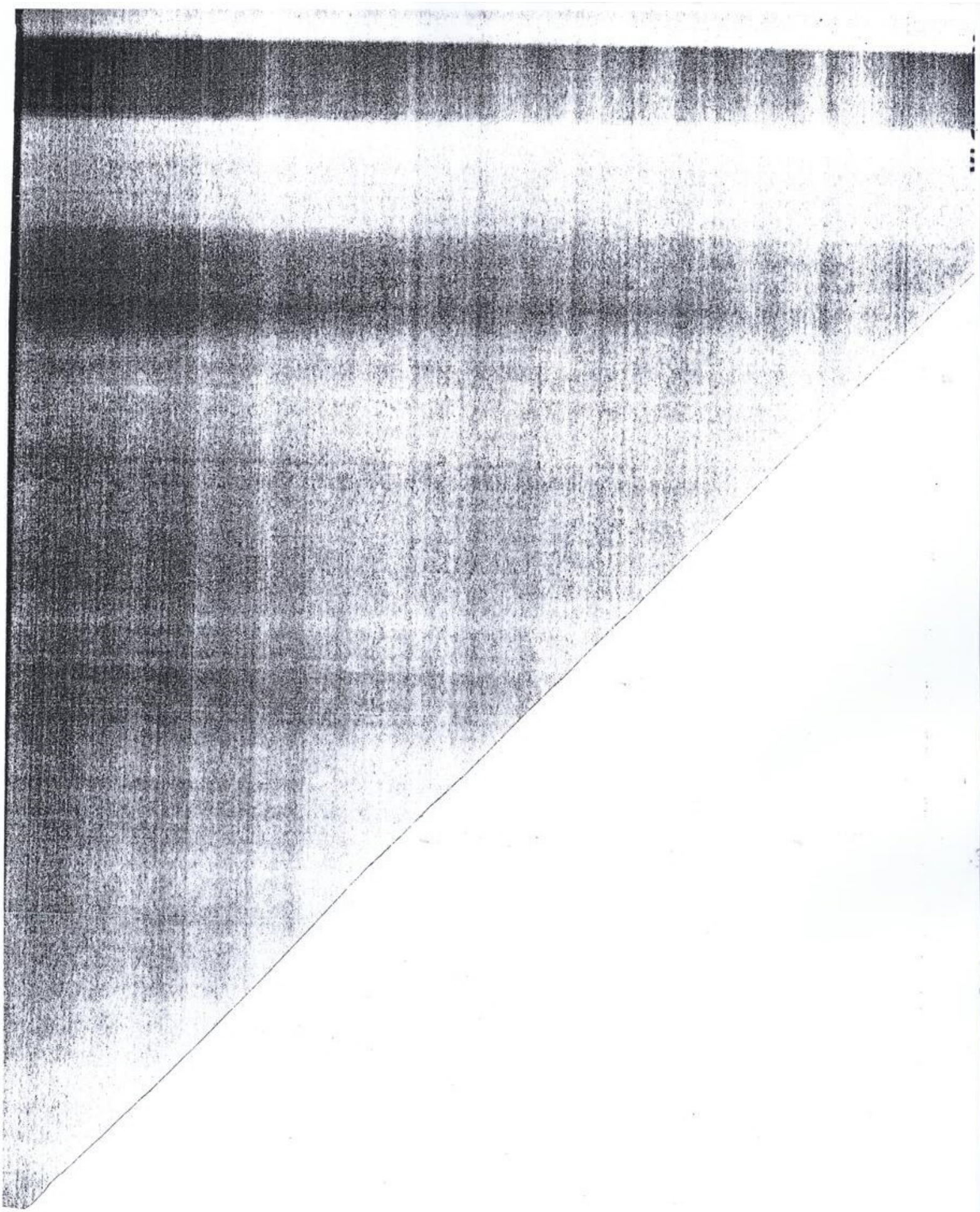
The degree to which nuclear tests could be covertly conducted under a test ban treaty are discussed in Appendix IV. The developments which might result from such tests have been noted in the previous sections. Two facts are worthy of further emphasis withrespect to clandestine testing:

A. The U. S. S. R. can conduct extensive weapons development and weapons effects programs with covert tests below the levels of detection-underground, in the atmosphere, and in space.

B. While intelligence may reveal evidence of some covert tests, if they should be conducted, the treaty contains no provision to exploit such evidence by inspection--only seismic signals which permit epicentri location will suffice for inspection under the terms of the treaty which is now being negotiated. No recourse is provided in the event of space tests, short of withdrawal from the treaty.

## VI. RECOMMENDATION

We recommend that the Air Force make clear to higher authority the extent of the military risks inherent in a nuclear test ban.



## APPENDIX I

# SUMMARY OF FUTURE EFFECTS TEST REQUIREMENTS*

Report by the Twining Committee

to

The Chief of Staff, U. S. Air Force

4 March 1963

*Excerpts from a report submitted to DDR&E/OSD by W. G. McMillan, Chairman of DDR&E Ad Hoc Weapons Effects Group.

# APPENDIX I

## SUMMARY OF FUTURE EFFECTS TEST REQUIREMENTS*

### I. INTRODUCTION

The requirements for additional information on weapons effects and weapon systems vulnerabilities are indicated elsewhere in this report. In this Appendix a number of specific effects tests are proposed to respond to the most critical needs. Some of the proposed tests have already been reasonably well defined by various studies; some are even in an advanced stage of planning. Others can be only roughly characterized at this writing, and the detailed specifications of the test parameters must await further analysis.

Since budgetary, technical and political constraints may limit the rate of future nuclear testing, it is useful to classify each proposed test according to an evaluation of its degree of urgency and relevancy to U. S. military systems. The first priority includes those tests designed to remove critical uncertainties and possible defects in existing and programmed major weapon systems. Tests in second priority have as their primary purpose the provision of information essential to the planning of future weapon systems. There is a third category of tests which, though perhaps most important in the long run, have not been motivated up to this time, by immediate and pressing weapon systems requirements. These are the tests aimed at acquiring fundamental knowledge of the physics of weapons effects. A number of such tests have been proposed but are not included in this Appendix. However, we believe that if atmospheric testing resumes, at least some of these fundamental experiments should and will be carried out.

*The tests proposed in this Appendix were submitted to DDR&E/OSD by W. G. McMillan, Chairman of DDR&E Ad Hoc Weapons Effects Group. Inclusion of the proposal in this report is intended to indicate agreement and to add emphasis on the importance of an active, well-supported test program.

Since the political climate may permit--or even force--U. S. resumption of atmospheric tests in advance of present DOD planning dates, we have also felt it important to give at least a crude estimate of the time required to prepare the various tests. It is perhaps a worthwhile reminder that certain tests can provide very useful information on a short time scale, as was demonstrated in the PEAR (CHECKMATE) shot.

## II. FIRST PRIORITY TESTS

### A. PROOF TEST OF MINUTEMAN MISSILE SITES

Originally our hardest missile silos (MINUTEMAN) were designed to withstand an overpressure level of 100 psi, which was later reevaluated as 300 psi. While enough was known concerning air blast to design the silo door with fair confidence, relatively little was known about the kind of earth motions which result from surface nuclear bursts and the kind of earth motions which might damage a silo or its contents.

Although the electromagnetic pulse effect was known to exist, its relevance to missile-site vulnerability was not fully appreciated until called to our attention by British scientists. Even then, little could be done to thoroughly evaluate the danger because of the lack of close-in electromagnetic measurements. One near-in measurement on the PLUMBBOB PRISCILLA test, a 40 KT shot at an altitude of 700 feet on a tethered balloon over Nevada, indicated a disturbingly large, low frequency vertical component of the magnetic field. When extrapolated to yields of one megaton or greater, it appeared to represent a severe danger of rupturing communications and command cable loops in a missile complex. There was, and has continued to be, considerable disagreement on this effect due to the lack of any reliable theory, disagreement in the limited measurements, and lack of confidence in the extrapolations.

Although the need for a surface test in the megaton range was clearly recognized for the electromagnetic pulse effect and the blast and shock effects, this was not possible on the short time scale allowed

for preparing the U. S. 1962 test series. In addition to the time limitation, an appropriate site was not available with appropriate elements--silos, cable loops, control center, etc.

[redacted] While it was recognized that this test was incapable of giving the direct information applicable to a high yield shot, the yield was chosen as probably the largest politically acceptable for a surface test in Nevada.

[redacted] The Air Force has undertaken the design of such a test and will submit a proposal to the Director of Defense Research and Engineering for approval in late March 1963. Additionally, a joint working group, the RUFUS Committee, has been established under the aegis of the Lawrence Radiation Laboratory to select a suitable site.

These shots should be especially instrumented for effects of EMP and near-in earth shock. To assure that the proof tests give maximum information and to provide a sound theoretical basis for extrapolating to other conditions of yield, soil characteristics, bomb asymmetry, fusion vs fission, etc., several smaller yield exploratory shots will also be required. One such exploratory shot is a symmetrical explosion of a few kilotons over salt water, which provides a simple boundary condition for the EMP. [redacted]

Since ultimately we must depend upon theory to translate the results of a limited number of experiments into an over-all assessment of vulnerability, a full-time theoretical group should be established and assigned the responsibility for detailed specification, design and interpretation of these EMP experiments.

Table 1

MINUTEMAN PROOF TEST PROGRAM

| Purpose | Yield | Altitude | Conditions | Location | Lead Time(M |
|---|---|---|---|---|---|
| [redacted] | | Surface | Over salt water | PPG | ~12 |
| | | " | " | | ~12 |
| | | " | [redacted] | NTS? | ~12 |
| | | " | | Alaska? | ~24 |

## B. DEVELOPMENT AND TESTING OF HARDENED R/V's

1. X-RAYS--Above the atmosphere the x-rays from a nuclear explosion travel unimpeded to great distances. If these x-rays impinge on the surface of a reentry vehicle in sufficient intensity, their energy, deposited in a thin surface layer, causes an explosive vaporization which may damage the R/V structure and warhead.

In order to obtain more direct information on R/V's exposed to x-rays in space, an attempt was made to carry several R/V's on the STARFISH launcher and expose them to the bomb x-rays at predetermined distances. The failure of the first STARFISH vehicle, which disintegrated at ~40 Kft, has been ascribed to the fact that it carried a mixture of pods and R/V's. Subsequent STARFISH firings did not include R/V's; hence, this important part of the experiment was not accomplished.

STARFISH PRIME was successfully launched carrying three instrumentation pods which were designed to be spin-stabilized in order to expose numerous small samples of nose cone materials to the x-ray flux. Unfortunately, the pods were not well-oriented and gave little information of value on this effect.

[redacted]

As far as the problem of the vulnerability of actual R/V structures is concerned, however, we still require the exposure of full-scale vehicles to x-rays, followed by an evaluation of the resulting damage with respect to reentry. [redacted]

2. NEUTRONS--Another type of long-range damage to an R/V exposed to a nuclear blast is that which results from the fission heating produced by neutrons captured in the fissionable material. Depending upon the neutron flux, this heating may produce dimensional distortions, phase transitions, melting or even vaporization. Since there exist highly developed numerical codes for calculating neutron transport, this aspect of warhead vulnerability was thought to be calculable. [redacted]

Considerable effort is going into learning how to harden warheads to neutron effects. It seems probable that this knowledge will be needed in designing future reentry systems. [redacted]

[redacted] But this is just another example of how easy it is to overlook an essential point in the absence of experiments.

[redacted]

The absence of this critical information leaves an important gap in our understanding of missile vulnerability. The Air Force has been directed by the Secretary of Defense to plan and design a test to study this effect. This plan was submitted for approval in late February 1963. The program, originally directed exclusively toward the Mk 11 reentry system, has been reoriented to include the equally important measurements necessary to guide the Mk 11a and Mk 12 hardening programs now under study. Most important of all will be tests on hardened reentry systems, when they have been designed and built, to be sure that no significant vulnerabilities have been overlooked.

To develop hardened R/V's that can survive nuclear attack during reentry requires a capability--such as proposed in the Air Force SLEIGHRIDE program. Coupled with such proof tests on hardened vehicles is the need for some simpler preliminary tests to provide critical and timely information in the design stage of the hardened R/V's, specifically for the MINUTEMAN Mark 12 system, now authorized. One such preliminary test is to expose a hardened R/V to combined neutron and blast effects without reentry. At the relevant vulnerability distances for hardened vehicles the shock velocity is appreciable (compared with the reentry velocity); therefore, helpful information can be obtained in this way. [redacted]

Table 2

TESTS FOR R/V HARDENING

| Purpose | Yield | Altitude (km) | Conditions | Location | Lead Tim (Mo.) |
|---|---|---|---|---|---|
| [redacted] | | ~10 | A/C or balloon | PPG | 6-8 |
| | | 10-20 | Variable standoff distances | See below | 18-24 |
| | | ~100 | " | " | 18-24 |

The most direct way of carrying out the reentry experiments is to launch from the continental U. S., as proposed in the SLEIGHRIDE program. The long lead time required to do this, however, makes it urgent to know that approval would be given for launching a warhead-carrying missile from the ZI when atmospheric testing is resumed. If the guarantee of such (conditional) approval cannot soon be achieved, an alternative plan would be made for launching from Johnston Island with the selection and development of an appropriate target area and down-range instrumentation. A second alternative could include launching non-nuclear R/V's from Vandenberg and intercepting with nuclear devices fired from Christmas or Johnston Island.

## C. REDUCING FIREBALL BLACKOUT

Altitudes below ~25 km may be of little interest for precursor bursts, since this already represents a fairly deep penetration. Such altitudes are of interest, however, for the ABM system itself, since intercepts would be made in this region. Although the fireball blackout

*It would be desirable also to have an underground x-ray experiment in which actual hardened R/V's could be exposed for study of structural response and integrity. [redacted]

produced by nuclear explosions below about 25 km is relatively localized, it is both intense and long-lived. Thus if the ABM system is faced with multiple warheads which must be attacked simultaneously, it may find it difficult to operate in the environment of multiple fireballs even though several radars are employed.

In understanding fireball blackout both the BLUEGILL and TIGHTROPE results are relevant, as are also some of the fireball measurements made on the weapons development drops at Christmas Island. Again this data is incompletely analyzed. The initial fireball dimensions in the relevant altitude regime are fairly well predictable from pure hydrodynamics. However, there does not yet exist the capability to calculate theoretically the subsequent hydrodynamic motion--especially the development of the toroidal cloud and the spatial distribution of the fission debris. Also, because of uncertainties in the air chemistry, the magnitude and duration of the fireball blackout cannot be accurately predicted.

[redacted]

Table 3

TESTS TO REDUCE FIREBALL BLACKOUT

| Purpose | Yield | Altitude (km) | Conditions | Location | Lead Time (Mo.) |
|---|---|---|---|---|---|
| [redacted] | | 10-20 | [redacted] | J. I. | ~12 |
| | | 10-20 | | " | ~12 |

## D. COMMUNICATIONS BLACKOUT

The importance of nuclear blackout on communications has been recognized since the TEAK event, which knocked out many communication links for hours. As a by-product of the present high altitude series, considerable additional information on this effect has been obtained. Within the range of our experience it may now be possible to make fair estimates of the extent and duration of such blackout, provided the explosion occurs at night. In daylight, photodetachment can play an important role, as we know, because the communications circuits knocked out by TEAK around midnight and re-established in the pre-dawn hours were knocked out again at sunrise. The blackout from a daytime shot--both radar and communications--might thus be far greater than for a corresponding nighttime event. It is a curious fact that all of the U. S. high-altitude shots have occurred in darkness, while all of the Soviet high-altitude shots have occurred in daylight.

To meet the operational demands for positive control in a nuclear environment, a large-scale high-altitude nuclear communications blackout test with full operational participation (SAC, NORAD, etc.) has been suggested. In order to examine and better define this requirement, an early review has been proposed, under the auspices of the DDR&E/OSD Ad Hoc Weapons Effects Group, of the communications systems and problems of the various operational commands. In this connection the Secretary of Defense has directed the Defense Communications Agency to make a comprehensive analysis of the vulnerability of the communications systems to blackout effects in case of large attack. [redacted] Such a test could probably be prepared in 6 to 8 months' time.

Table 4
TEST FOR COMMUNICATIONS BLACKOUT

| Purpose | Yield | Altitude(km) | Conditions | Location | Lead Time (Mo.) |
|---|---|---|---|---|---|
| [redacted] | | ~75 | Daytime | J. I. | 6-8 |

## III. SECOND PRIORITY TESTS

### A. BETA & GAMMA BLACKOUT

The best counter to a ballistic missile defense would probably be lightweight, realistic decoys. Considerable effort is going into developing such decoys, but since the problem is far from solved, we are forced to explore other penetration aids. One promising aid is radar blackout from nuclear explosions.

1. BETA BLACKOUT -- The usefulness of radar blackout as a penetration aid depends both upon the type of blackout and the type of defense. To be effective, the blackout must be sufficiently intense to cause serious attenuation at the radar frequencies of interest, last for the tens of seconds required for the follow-on R/V to penetrate below the minimum commitment altitude, and extend over such a large area as to blind all radars defending the target. For a comparatively slow-reacting system like Nike Zeus, which must commit at an (incoming-missile) altitude in excess of 200,000 ft., beta blackout may satisfy these conditions.

Although beta blackout may not be effective as a penetration aid against a quick-reacting defense, there is no evidence that the Russians are developing such a system; therefore, it seems desirable to have an operational capability for creating this type of blackout.

[redacted]

[redacted] (Again, the blackout will be enhanced by photodetachment if conducted during daylight.)

[redacted] However, if only one test were allowed for the purpose, we would recommend the 150 km shot since it appears (theoretically) more promising for the production of operational beta blackout. [redacted] Furthermore, such a shot could be used to demonstrate the daytime x-ray blackout of HF communications. This effect is of interest because theory indicates that in the daytime even a few tens of kilotons (of x-rays) produced at an altitude of a few thousand kilometers can influence HF communications for about half an hour over a large fraction of the earth's surface.

Table 5

TESTS TO PRODUCE BETA BLACKOUT

| Purpose | Yield | Altitude (km) | Conditions | Location | Lead Time (Mo.) |
|---|---|---|---|---|---|
| [redacted] | [redacted] | 150 | [redacted] | J. I. | 6-8 |
| | | 115 | | " | 6-8 |

2. GAMMA BLACKOUT--In part because of the difficulties posed by beta blackout, U. S. thinking with respect to possible ABM defenses has turned increasingly toward a quick-reacting system, perhaps involving a combination of phased-array radars and sprint missiles. Such a system appears capable of acquiring at altitudes as low as 25 or 30 km and still intercepting at a sufficiently high altitude to make a substantial reduction in ground damage, even assuming the incoming missile is sympathetically detonated. The possibility of such a quick-reacting system leads to the question of whether blackout can be produced at altitudes considerably below the 70 km beta-deposition layer Theory indicates that such low-altitude blackout can be produced by gamma rays.

Preliminary analysis of the BLUEGILL data appears to confirm that the production of operationally significant gamma blackout is feasible. The signal from a rocket-borne kilomegacycle beacon transmitting (one way) through the gamma ionization layer at a lateral distance ~50 km from the burst point was attenuated some tens of db for a few seconds. The blackout can presumably be increased substantially by raising the (fission) yield, since the attenuation at a given time scales directly with yield. The BLUEGILL data incidentally confirm that photodetachment due to light from the fireball contributes to prolonging the blackout, especially within the upper portions of the ionized layer.

3. REDUCING GAMMA BLACKOUT--[redacted]

Table 6

TEST FOR THE REDUCTION OF GAMMA BLACKOUT

| Purpose | Yield | Altitude (km) | Conditions | Location | Lead Tim (Mo.) |
|---|---|---|---|---|---|
| [redacted] | | 50 | [redacted] | J. I. | 6-8 |

## B. PROTECTIVE STRUCTURES

While the MINUTEMAN proof test discussed above would involve extensive earth-shock measurements, these would be for the most part pertinent to the relatively low hardness level for which the MINUTEMAN silos are designed and, therefore, would not be applicable to the problem of designing very hard command and control posts deep underground. [redacted] If these indications could be verified soon by experiment, superhard command and control centers could be built at considerably reduced depth and correspondingly reduced costs. Two tests are proposed. [redacted] Preparations for this experiment have been authorized by DDR&E and funds have been programmed. The second test would provide the missing connection between such tamped underground explosions and surface bursts. To this end, a hardened structure at a depth of several thousand feet, deep in granite, should be subjected to a large yield surface burst directly overhead. Conceivably this might be an adjunct of the MINUTEMAN proof test.

Table 7

PROTECTIVE STRUCTURES TEST PROGRAM

| Purpose | Yield | Shot | Structures | Medium | Location | Lead Tir (Mo.) |
|---|---|---|---|---|---|---|
| [redacted] | | | | Granite | NTS | ~12 |
| | | | | " | Same as EMP MM site? | ~18 |

[redacted] These tests will be ready by mid-1964.

## IV. LONG LEAD-TIME ITEMS

It seems possible that we might someday be forced to conduct a weapons effects test program on an arbitrarily imposed time scale. Our experience in the recent Pacific tests shows the importance of developing not only the measurement techniques specific to a given test, but also such general capabilities as launch and tracking facilities. We strongly urge that the present breathing space be used to:

* Refine tracking and relative position measurement of several simultaneous radar objects.

* Adapt the THOR vehicle to carry various types of R/V's and pods.

* Adapt solid propellant missile (e.g., Polaris, Sergeant booster, etc.,) as alternative launchers.

* Wed a spectrum of warheads to the various missiles.

* Eliminate unnecessary ballast and fuel; develop tankage separation.

* Provide a sufficient number of launching pads to handle maximum traffic.

* Extend permissible THOR launch azimuth, perhaps by the reversal of yaw and pitch controls.

* Requisition and procure instrumentation rockets, recently in critically short supply.

* Instrument three C-135 aircraft for airborne diagnostics. (The Air Force has been directed by the Secretary of Defense to provide these for AEC instrumentation.)

* Provide replacement aircraft for the samplers used in Operation DOMINIC. These aircraft are well beyond their designed life and are marginal in both altitude and range for the sampling mission.

Even though no definitive answer can yet be obtained on whether and when atmospheric testing will again be allowed, several critical decisions must be made immediately in order that preparation can go forward. These include:

* The siting of the MINUTEMAN proof test.

* The choice and authorization of the launch and impact locations for the dynamic reentry experiments.

* The authorization for the release and commitment of a substantial fraction of the total cost of the test series to provide for long lead-time procurement.

In the present political climate the U. S. must insure its ability to conduct nuclear weapons effects tests on short notice, even though the cost of such insurance may run to tens of millions of dollars.

APPENDIX II

# THE EXPANDING FRONTIER OF NUCLEAR TECHNOLOGY; REASONS SPECIAL TO THE UNITED STATES FOR MOVING PROMPTLY AHEAD

Report by the Twining Committee

to

The Chief of Staff, U. S. Air Force

4 March 1963

## APPENDIX II

## THE EXPANDING FRONTIER OF NUCLEAR TECHNOLOGY; REASONS SPECIAL TO THE UNITED STATES FOR MOVING PROMPTLY AHEAD

### I. WIDENING DIVERSITY OF NUCLEAR TECHNOLOGY

We have examined an argument sometimes advanced in connection with a nuclear test ban that "There is no new development in nuclear explosion technology for which the United States has vital need."

This claim, we are forced to conclude, rests on a complete misestimate both of the future of nuclear technology, and of the dangers--implicit in this technology--of our present nuclear position vis-a-vis the Soviets.

The technology has already outstripped that primitive measure of merit known as the "yield-to-weight ratio." This ratio is surely relevar to the destruction potential of a ballistic missile warhead. It is also the quantity most easily evaluated in a test, even by an observer at a distanc Therefore, it is not surprising that comparisons of U. S. and Soviet shot focus attention upon this yardstick of accomplishment. [redacted] Such a narrow view would look at Watt's engine pumping water out of a mine, compare its efficiency with the theoretical limit of so many pounds of water per pound of coal burnec and conclude that the steam engine could not much affect civilization!

Engine technology has grown in part through improvements in efficiency, but much more through widening applications. Similarly,

weapons technology today is concerned in part with the yield, but more with the effects of explosions. There is no one magic application on which attention can focus to the exclusion of everything else. Nothing makes more impression on one reviewing the new developments than the ever-widening diversity of nuclear technology.

## II. TACTICAL WEAPONS

[redacted] These weapons would greatly increase our options in tactical warfare by essentially closing the gap in the tactical firepower spectrum.

A. We would here quote from the Air Force SAB Strategic Concepts Ad Hoc Committee Report on Future Nuclear Weapons of December 1962.

"The cost of the fuel of these weapons will be small; their cost will be largely the fabrication cost.

"Some implications of such developments are: (1) Any nation which has a modern industrial capacity can make such weapons. There are many nations today with adequate capabilities and others can develop the capability. It is conceivable that others may be able to purchase such weapons. (2) [redacted]

[redacted] (3) The distinction between conventional weapons an nuclear weapons will tend to disappear. [redacted] These weapons will produce little or no radioactive fall-out or debris. The basic concepts of personnel kill with small weapons will change from blast effects to neutron effects which will have little destructive impact on physical features of buildings, manufacturing faci ties, etc. (4) Our present stockpile of weapons will be rendered obsolet The fissile material could be made available for reactor or other uses. (5) [redacted] (6) The impact on limited warfare could be great. [redacted] (7) Since there is no known protectio against fusion weapons, except for shielding and dispersal, limited war-fare tactics will be greatly altered. Furthermore, it is probable that the balance of power with respect to limited warfare will rest with the nation which first perfects these weapons and produces them in large quantities [redacted]

If these ultimately inexpensive devices can be made at all--as seems likely--then second level nations can make them. If we do not keep the scientific leadership, others will take it. No responsible pro-ponent of any detection system has claimed ability to detect a small pure hydrogen detonation underground.

If the United States is to renounce a revolutionary device which others can then secure without our knowledge, no portion of this responsi-bility should attach to the Air Force.

easy and certain. (3) The distinction between conventional weapons and nuclear weapons will tend to disappear. Once the technology is available fusion weapons can be made of any desired yield, very small as well as very large. These weapons will produce little or no radioactive fallout or debris. The basic concepts of personnel kill with small weapons will change from blast effects to neutron effects which will have little destructive impact on physical features of buildings, manufacturing facilities, etc. (4) Our present stockpile of weapons will be rendered obsolete. The fissile material could be made available for reactor or other uses. (5) These pure fusion weapons will have an important impact on strategic weapons because of their lack of vulnerability to neutron kill. (6) The impact on limited warfare could be great. The ultimate small size and low cost mean that they may be used in great quantities by ground armies and by tactical air forces. They could be used with all types of launchers perhaps even hand-fired weapons. (7) Since there is no known protection against fusion weapons, except for shielding and dispersal, limited warfare tactics will be greatly altered. Furthermore, it is probable that the balance of power with respect to limited warfare will rest with the nation which first perfects these weapons and produces them in large quantities."

B. A test ban will stop the active U. S. effort to develop a technology of pure hydrogen devices free of fission fallout. No one can exclude the possibility that in three to ten years such a technology will outdate present nuclear weapons and revolutionize ground warfare.

If these ultimately inexpensive devices can be made at all--as seems likely--then second level nations can make them. If we do not keep the scientific leadership, others will take it. No responsible proponent of any detection system has claimed ability to detect a small pure hydrogen detonation underground.

If the United States is to renounce a revolutionary device which others can then secure without our knowledge, no portion of this responsibility should attach to the Air Force.

## III. DIRECTED ENERGY

Possibilities exist for achieving a high degree of energy directivity of nuclear explosions in space. The most obvious applications are mid-course decoy discrimination of ICBM decoys, boost phase kill of ballistic missiles, and pre-terminal defense against missiles.

The concept is one of producing narrow cones of either high velocity vapor or high velocity solid particles which might intercept ballistic missiles or their warheads at greatly extended ranges from the intended target area. This work cannot be carried forward effectively without tests. However, important progress is possible at a level of underground testing which is below the threshold for detection.

## IV. SPACE PROPULSION

There is another area where preliminary exploitation is likewise possible with tests which are below the level of reliable detectability, and likewise impossible if all tests are banned: propulsion by nuclear explosives. This concept might make possible the transportation of payloads from a hundred tons to tens of thousands of tons. Among the uses one can visualize for such a propulsion system, the most obvious military application would be a detailed continuous surveillance of the earth's surface by a massive manned space vehicle.

The range of application of this principle of propulsion by explosive drive might be extended if pure fusion explosives become available. For then the "critical mass" is many orders of magnitude smaller than the critical mass for fissile material which triggers all present-day nuclear explosives.

## V. GEOPHYSICAL EFFECTS

The interaction of nuclear bursts with the natural environment is so poorly understood that we are not only unable to assess the effects of various things that could be done, we cannot even be sure of avoiding

inadvertent large scale effects. For example, the STARFISH shot temporarily modified the earth's magnetic field in an important and unexpected way. It should be noted that the total energy of the earth's magnetic field is comparable to 300 MT. Various combinations of high yields and directed electron beams have the potential for important effects that we only dimly perceive.

It also is likely that significant climatic effects could result from various acts that are already within the capabilities of our technology, such as blocking or enlarging marine canyons to alter ocean currents or triggering other sensitive climatic levers.

Since these new dimensions of effects are coming within the capacity of our technology, it is important that we increase our efforts to understand phenomenology and assess effects either with or without nuclear testing. Such a conclusion suggests both a need for increased general understanding of natural environmental processes and a need for a systematic assessment of the known and suspected natural levers that could be affected by man-made events.

## VI. CONCLUSIONS

The technology of nuclear energy has its own laws and its own internal structure. It can be stopped by the hand of man as little as the advance of weaving machinery could be stopped by the Luddite mobs. But we can be stopped by our own actions. Out of a developing nuclear technology, we see emerging better defense and peaceful uses of nuclear energy. But the most important peacetime use of nuclear energy is the preservation of the peace.

## APPENDIX III

# PROBLEMS OF MAINTAINING STRONG WEAPONS LABORATORIES AND TEST READINESS DURING A TEST BAN

Report by the Twining Committee

to

The Chief of Staff, U. S. Air Force

4 March 1963

# APPENDIX III

## PROBLEMS OF MAINTAINING STRONG WEAPONS LABORATORIES AND TEST READINESS DURING A TEST BAN

### I. INTRODUCTION

The sudden breaking of the 1958 moratorium after extensive clandestine preparations enabled the Soviets to approach equality, perhaps even achieve superiority, to the U. S. in weapons effects knowledge and weapons development. To avoid a similar repetition of this serious military setback, the U. S. Arms Control and Disarmament Agency has stated the intention of maintaining during a test ban a continued preparedness to test by providing adequate incentives to weapon scientists and adequate budgets to maintain operational readiness.

"Maintaining readiness" infers that our current weapons laboratories and testing capability are at least on a par with those of the U.S.S.R. This is highly questionable.

There is reliable information that the Soviet weapons laboratories and nuclear testing facilities underwent major expansion during the 1958-1961 moratorium; U. S. laboratories lost momentum and our testing capability was intentionally disintegrated.

An analysis of the 1961 and 1962 series of Soviet tests show them to be the most extensive and complex in the history of nuclear testing. They not only demonstrated a "highly sophisticated nuclear weapons technology" [redacted] but exercised complete weapons systems, including both ground and naval launched ballistic missiles, surface-to-air missiles and underwater naval weapons. The Soviets also conducted very sophisticated high altitude effects shots in conjunction with their ballistic missile facilities at Kapustan Yar and their AICBM installations at Sary Shagan.

The current United States capability in our weapons laboratories, Task Force 8, and limited testing facilities will not permit us to approach the complexity or rate of the Soviet 1961-1962 testing without at least 18 months of comprehensive planning, preparations, and buildup.

## II. MAINTAINING STRONG WEAPONS LABORATORIES

The Committee attempted to establish the nature of the incentives and the likelihood of the continued budget support which could, with reasonable assurance during a test ban, build up and maintain U. S. readiness to test at a rate already achieved and demonstrated by the Russians. So far as incentives are concerned--money, patriotism, scientific challenge and prestige were explored.

Money appeared to be a far-from-adequate incentive. The most competent scientists have consistently traded monetary reward for freedom of research and the right to work on what they believe to be the most important and challenging problems. There is no question that even today, in the face of urgent problems bearing on U. S. national security, the majority of our best scientists are in universities at reduced salaries spending only a fraction of their time on problems of national security.

So far as patriotism is concerned, it is difficult to see how it could be a compelling incentive to work on weapons in the face of a Government-sponsored moratorium. The very fact of a test ban and the many past statements by Government spokesmen questioning the importance of weapons testing and weapons development as compared with other areas of national security would lead our competent scientists to believe that our national security would best be served in other areas.

In the absence of testing, it would be difficult to justify weapons development as a scientific challenge. Without experiments to verify or demonstrate the validity of a new scientific theory or concept, which is the very essence of the scientific method, a competent scientist could not long continue to feel that his efforts were meaningful.

Without means to demonstrate that his ideas were meaningful and right, the most important form of prestige, that of recognition of the correctness of his ideas, would be denied.

The only incentive which the Committee could foresee as adequate to retain the country's competent weapons scientists was the opportunity for experimental work--weapons tests. In a nuclear weapons laboratory about one-half the scientific competence is devoted to understanding the transport of energy from the primary of a nuclear device to its secondary. [redacted]

## III. MAINTAINING TEST READINESS

In examining the second part of the proposal of the U. S. Arms Control and Disarmament Agency--to provide adequate budgetary support to maintain operational test readiness--the Committee notes that the Executive Branch cannot guarantee a decision on budget, which fundamentally resides with the Legislative Branch. Moreover, even if the Executive Branch could persuade its contemporary Congress of the need for such support, both the Administration and the Congress will change with time and the continuity of adequate budgetary support would be threatened. The competition for the limited defense funds by seemingly greater urgencies and emergencies would inevitably corrode the resolve to maintain a standby test readiness of the necessary magnitude. The prospect of heavy investment in large test facilities (e.g., like the simulated MINUTEMAN complex required for a proof test, or the SLEIGHRIDE launch, tracking and intercept facilities) having less-than-certain probability of being used, is bound to generate severe objections. With each subsequent year, the large budgetary request demanded for replacement of instrumentation and necessary updating in the light of new systems developments will become increasingly hard to defend against drives for economy. Therefore, it seems most unlikely that the necessary state of test readiness could long be maintained under a test ban.

As a final point, the policy enunciated by the U. S. Arms Control and Disarmament Agency does not reckon with one of the most severe

difficulties encountered in the recently concluded U. S. Pacific test series, namely, the location and reassembly of experienced test technicians. Over the objections of many people concerned with the advance of nuclear weapons technology, Joint Task Force 7 was completely disbanded during the past moratorium. By the time Joint Task Force 8 was authorized, the experienced test personnel had become widely diffused throughout industry and the military services, and it was only at the cost of great effort and delay that key people could be reassembled.

In summary, the Committee could not convince itself that during a test ban, adequate budget and incentives could be provided to build up and preserve the U. S. capability and readiness to test. On the other hand, it foresaw no significant problem for the totalitarian Soviet state to maintain weapons research and test preparedness.

## APPENDIX IV

# THE OPPORTUNITY FOR COVERT ACTION UNDER A NUCLEAR TEST BAN

Report by the Twining Committee

to

The Chief of Staff, U.S. Air Force

4 March 1963

# APPENDIX IV

# THE OPPORTUNITY FOR COVERT ACTION UNDER A NUCLEAR TEST BAN

## I. INTRODUCTION

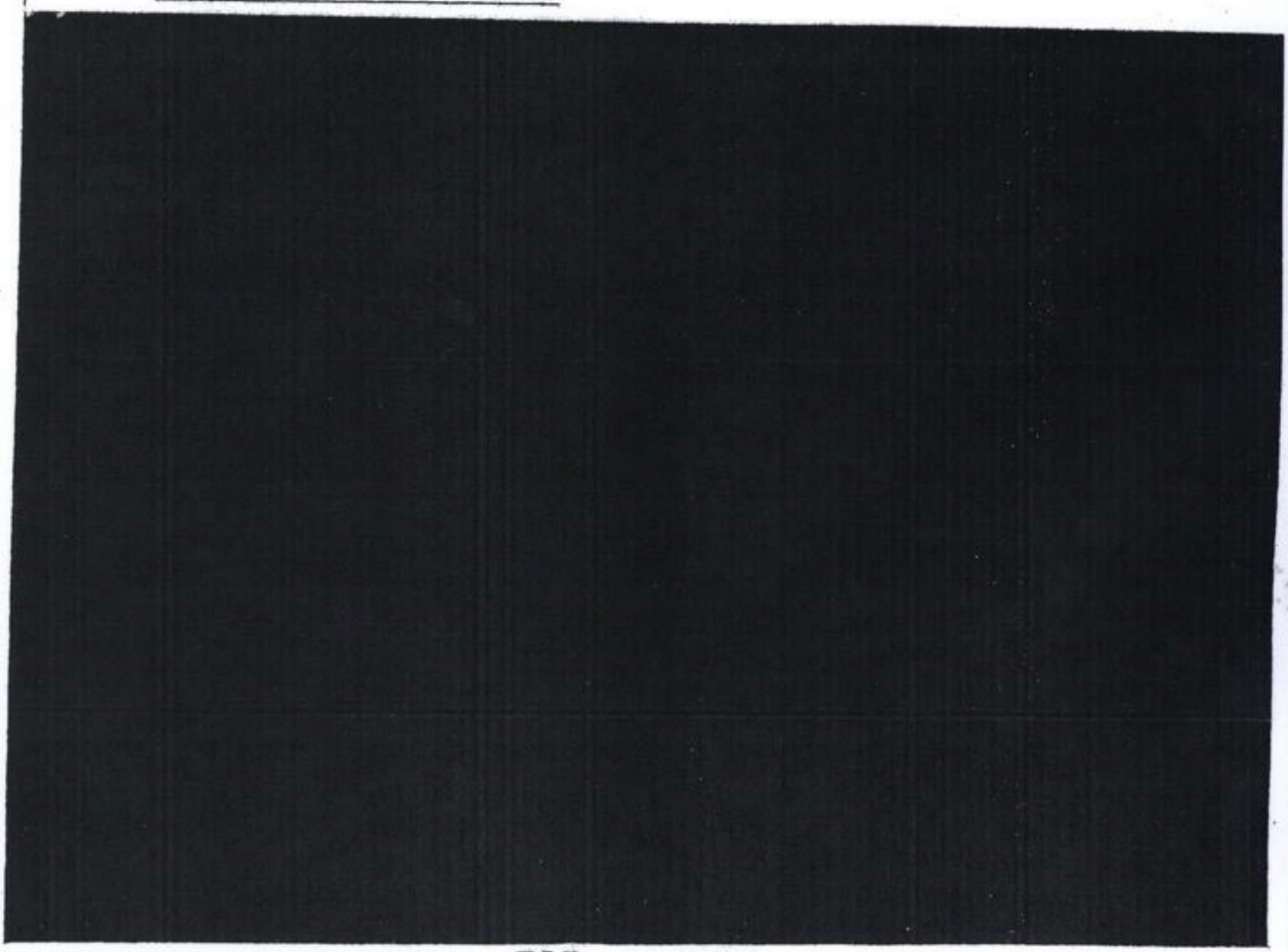
United States national policy has consistently demanded that any test ban agreement with the Soviet Union should be adequately controlled in order to assure Soviet compliance. The vital importance of this principle of control was demonstrated by the clandestine Soviet test preparations carried out under cover of the 1958 moratorium and which resulted in the Soviet breaking of the moratorium with their extensive and highly coordinated 1961 test series. These Soviet actions together with their recent 1962 test series show a very determined Soviet desire to achieve nuclear superiority over the U.S. in all aspects of nuclear weapons technology--superiority in efficiency and variety of nuclear weapons and superiority in knowledge of weapons effects. It is critical therefore to know the opportunities which a test ban agreement could afford the Soviets to pursue clandestinely their goal of superiority while the U.S. adheres to a test ban. The following discussion describes the nature of the nuclear tests which the Soviets might conduct without detection under a test ban agreement and points out some of the obvious gains which they could achieve through such tests.

In the event of a test ban agreement between the United States and the Soviet Union, the U. S. will place heavy--and perhaps total--reliance on a control system entirely outside Communist territory in order to monitor Soviet compliance. The capability of such a control system will be substantially the same as the current U.S. National Atomic Energy Detection System (AEDS), although some modest improvements in the capability might be expected after a few years of continued research under Project VELA.

## II. ESTIMATED DETECTION CAPABILITIES

AFTAC has made estimates of the present capability of the AEDS for detecting Soviet tests conducted underground, in the atmosphere, and in near space. For unshielded shots at high altitudes and in deep space, and for the same when shielded, estimates of U. S. detection capability have been made from information contained in the report and minutes of the Technical Working Group #1 of the Geneva Test Ban Conference. These estimates for detecting tests in all environments are presented in Figure 1.

### A. UNDERGROUND TESTS



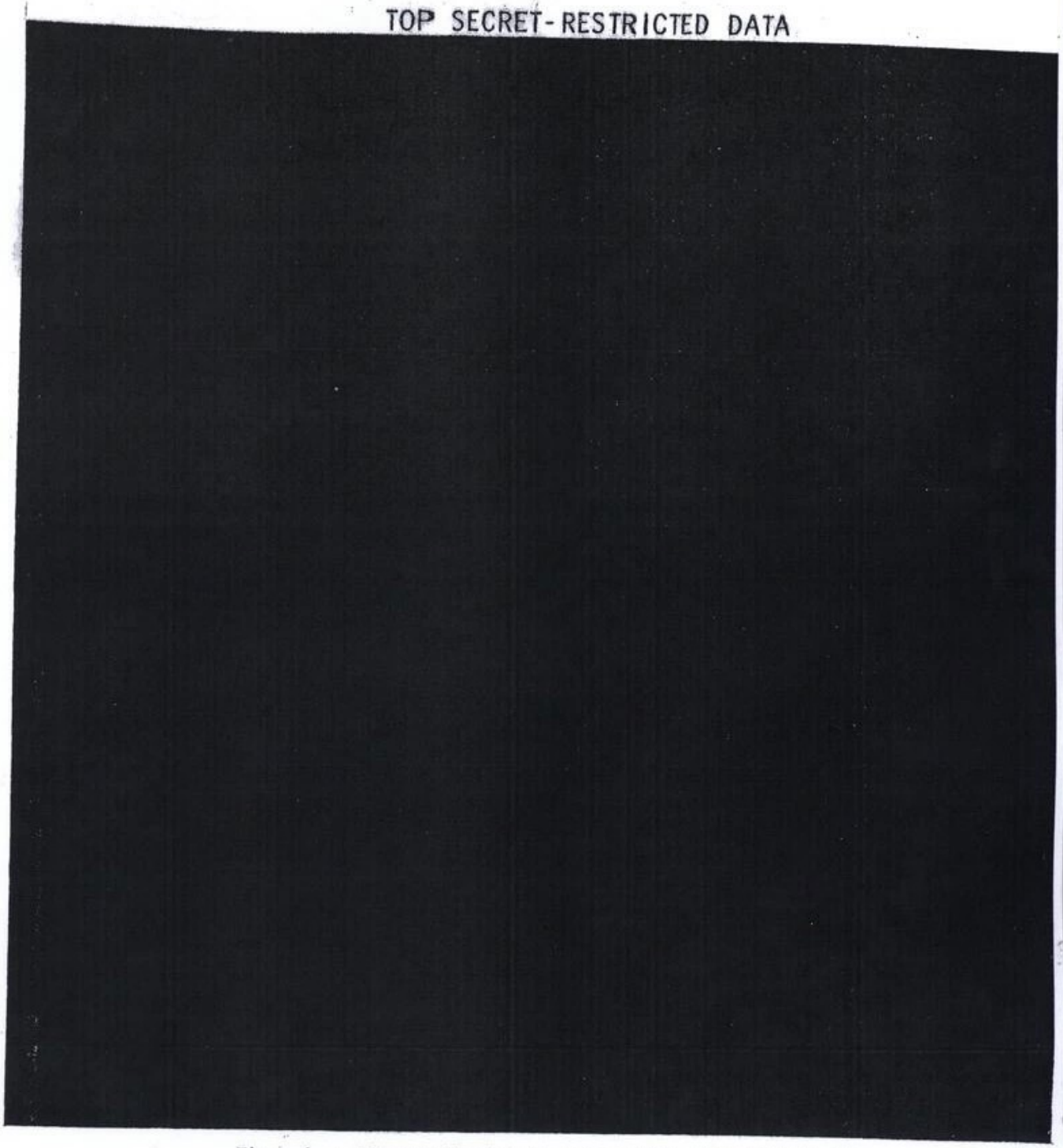


Fig. 1 - Theoretical Estimates of Limits of Detection of Nuclear Explosions Underground in the Atmosphere and in Space

B. ATMOSPHERIC TESTS

[redacted]

C. HIGH ALTITUDE TESTS

[redacted]

D. SPACE EXPLOSIONS

[redacted]

## III. UNCERTAINTIES

[redacted]

There are significant differences of opinion about whether the Soviets would risk clandestine testing for fear of discovery by non-technical means and whether there is significant value to such clandestine tests.

The extent to which fear of discovery by non-technical means will deter the Soviets from undertaking clandestine testing depends strongly on the nature of the non-technical information and the use to which it can be put. In general, the type of non-technical information which might be obtained will be insufficient to prove that a clandestine test has been undertaken; at most, it might raise some suspicion. For example, visual observation of surface depressions produced by underground explosions in alluvium or visual observations of construction which might be associated with a large underground cavity or an unannounced launching of a satellite or space probe.

In none of these cases is the information adequate proof of violation. In the first two, inspection at the site of the suspected violation might provide proof of a clandestine test, but such inspection would not be allowed under a test ban agreement. In the case of a satellite or space probe launching, it is not even clear that suspicion is justified.

## IV. POSSIBLE GAINS FROM COVERT ACTION

The risk of discovery by technical means will be weighed by a violator in relation to the value of such tests. [redacted]

[redacted]

So far as weapons effects are concerned, re-entry vehicle vulnerability to X-ray and nuclear radiations can be studied and methods of hardening against these radiations can be developed. Moreover, limited studies of blast vulnerability of re-entry vehicles can be made. Considerable information can be obtained on the vulnerability of hardened missile sites and command and control centers to ground shock.

[redacted]

Gamma ray and fireball blackout could probably be adequately, if not completely, studied.

[redacted]

Some weapons effects information could probably not be obtained by clandestine tests alone, particularly full scale proof tests of system vulnerabilities. However, extensive theoretical analysis plus novel experimental techniques combined with clandestine testing might be sufficient to answer all important questions on weapons effects. For those tests vital to Soviet interests which could not be conducted clandestinely, it might be expected that the Soviets would resort to their earlier technique--preparation during the period of the test ban followed by sudden abrogation and an extensive, coordinated test series.

SECRET
RESTRICTED DATA

APPENDIX V

# MILITARY IMPLICATIONS OF U.S. AND SOVIET NUCLEAR TESTING

Interim Report by the Twining Committee

to

The Chief of Staff, U. S. Air Force

12 December 1962

12 December 1962

General Curtis E. LeMay
Chief of Staff
United States Air Force
Washington 25, D. C.

Dear General LeMay:

On 20 August you requested the committee which reviewed the military implications of the 1961 Soviet nuclear test series to re-convene to up-date its report of 5 January 1962.

The committee has made an assessment of related subsequent actions of both the United States and the U. S. S. R. and wishes to submit the attached interim report. A final report will be submitted within the next sixty days.

Sincerely yours,

N. F. Twining

N. F. TWINING
General, USAF (Ret.)
Chairman of the Committee

Members of the Committee

J. H. Doolittle, Lt Gen, USAF (Ret)
Dr John S. Foster, Jr.
Prof David T. Griggs
*Dr Conrad Longmire
Dr Gerald M. McDonnel
E. E. Partridge, Gen, USAF (Ret)
*Dr Simon Ramo
Dr Theodore B. Taylor
Dr Edward Teller
Dr Stanislaw M. Ulam
Prof John A. Wheeler

*Unable to participate in the meeting of 8-11 Dec 1962, in which this interim report was prepared.

JOHN A. WHEELER By O.P. Thorne

## NEW OBSERVATIONS SINCE THE JANUARY 5, 1962 REPORT OF THE TWINING COMMITTEE

1. Soviet Accomplishments:

a. In both the 1961 and 1962 Russian test series, explosions in the multi-megaton range were emphasized, while at the same time tests in all observable ranges were performed. [redacted]

b. Many of the Soviet 1962 tests appear to be tests of operational multi-megaton missile warheads and bombs, including extensive participation by military forces.

c. There is reliable information that Soviet facilities for the production of both U235 and Pu239 have been steadily expanding and that they are being substantially increased at present.

d. There is reliable information that Soviet weapons laboratories underwent major expansion during 1958-1961 and that they are now operating at full capacity.

e. There is evidence which might indicate Soviet preparations for future testing of nuclear devices.

2. U. S. Accomplishments:

[redacted]

[redacted]

d. The low yield test, performed in 1962, designed to help determine the vulnerability of the MINUTEMAN launching complexes to nearby bursts in the megaton range, provided inadequate data for this determination.

e. The STARFISH space test did not produce the blackout effects which had been anticipated, and many of the observed phenomena associated with the explosion are not understood. This test has displayed our state of ignorance of effects of nuclear explosions in space.

f. It has become clear that directional nuclear explosives can be made. Such explosives might be effective for use in defense against ballistic missiles.

g. During the last year and a half the U. S. has developed an adequate capability to perform underground experiments and has made progress in the development of the capability to conduct high altitude effect experiments and air drop tests of advanced warheads.

## OVER-ALL COMPARISON OF DEVELOPMENTS

3. The fact stands out that in recent years the Russian rate of progress in the development of very high yield weapons, and in the conduct of exceedingly complex system and effects tests has substantially exceeded our own. Since 1961 they have performed many more observable atmospheric tests than the U. S. The difference in the rate of development is, in part, a consequence of the different procedures followed by the U. S. and the U. S. S. R. during the moratorium. This is illustrated by

the following table:

| U.S. | U.S.S.R. |
|---|---|
| Interest in advanced weapon development declined. | A large new weapon laboratory was constructed and put into operation. |
| *Key weapon design personnel worked on test ban treaty, and spent extended time in Geneva. Large efforts were expended by weapons laboratories in detection and inspection problems. | No weapons laboratory people were at Geneva; there was no evidence of participation by weapons laboratories in test ban considerations or in detection efforts. |
| Task Force 7 was disbanded at completion of 1958 program. | Preparation was made for logistic support of the most extensive nuclear tests ever conducted. |
| No specific plans or preparations for new weapons testing were made. | New weapons were designed, fabricated, and prepared for tests. |
| No high-yield weapons designs were actively under consideration. | Very high yield weapons were designed and prepared for test with such confidence that Khrushchev could allude to a 100 MT weapon in January 1960 and could advertise its debut at the beginning of the test series. |
| Arguments were advanced against effective missile defense. No experiments were planned. | Missile defenses were planned and effective test procedures were initiated. |

4. From a review of the U. S. and Soviet actions during the nuclear weapons test moratorium, and a comparison of their respective nuclear weapons programs, it is clear that:

*Dr. Ulam disassociated himself with this observation.

a. The Soviets have a high priority and purposeful program which goes ahead regardless of nuclear test ban discussions. This program is one of depth and breadth. It includes the expansion of laboratories and testing and production facilities. The Soviets have ballistic missile ranges for live testing of weapons and investigation of offense-defense interactions, and an atmospheric test range for high yield weapons. Their program also includes weapons development, effects research, and operational testing of complete systems on a continuing and orderly basis.

b. The rate of progress of Soviet nuclear technology is greater than our own. The over-all balance as of today may be close, but the present trend is definitely unfavorable. Our own rate of progress has been retarded by the uncertainties which have accompanied our programs ever since the adoption of the moratorium in 1958. The uncertainties have had the following debilitating effects:

(1) Momentum, continuity, and quality of planning have been degraded;

(2) Recruitment and retention of highly qualified scientists and engineers have been difficult;

(3) Motivation and inspiration of personnel have suffered;

(4) The timely allocation of adequate resources has been impossible;

(5) The number and types of tests conducted have been circumscribed by various constraints; and

(6) Execution of tests, when finally approved, has suffered from lack of adequate preparation.

c. The most fundamental requirement which must be met, if we are not to surrender superiority in nuclear technology to the U.S.S.R., is the establishment of a positive U.S. policy for a vigorous nuclear weapons development and weapons effect program, with testing as

required. Because of the interaction of nuclear technology with other military technologies, the present trend, if not changed, will lead to an imbalance of both offensive and defensive military capabilities decisively favorable to the U.S.S.R. It is difficult to visualize an effective U. S. strategy under such circumstances.

## RECOMMENDED ACTION

5. There remain many possible technological advances in the design of nuclear weapons and the utilization of weapon effects that could have a major bearing on the balance of power. [redacted] Among these could be presently unknown effects relating to missile defense and penetration of these defenses. The committee wishes to restate its belief that we cannot afford to let the Soviets retain the initiative in pursuing such objectives while we continue to be "reactive."

6. Specifically, we make the following recommendations:

a. On a high priority basis we should reestablish a long range, well planned weapons research, development and testing program and a vigorous, systematic weapons effects analysis and testing program.

b. Underground testing should be continued. As this type of testing is easily planned and creates the least disruption of other activities near the test site, it should be used when effective. Above ground tests should be performed when a clear-cut necessity for such tests exists.

c. We recommend that a fully instrumented site for large scale atmospheric testing be established and maintained.

d. There are several important experiments involving atmospheric tests that can profitably be accomplished as early as the latter part of 1963 and these should be done. These include:

[redacted]

(2) [redacted] Preliminary tests can best be done by dropping such re-entry vehicles (TIMPANI devices) simultaneously with a live warhead from a B-52 at high altitude.

(3) Further high altitude effects experiments to resolve some of the major uncertainties relating to ballistic missile defense by comparing the results of clean and standard explosions of the same yield at the same altitude. The clean explosives developed during the last year now permit us to separate those effects which are due to fission in a manner which could not be obtained in the last series.

(4) Nuclear experiments conducted in deep space ($10^5$ - $10^6$ Km) can be used to perform experiments important both to scientific research and the development of high yield nuclear warheads. The early firing of a low yield warhead is important to the development of diagnostic techniques and understanding of space nuclear explosion phenomena.

APPENDIX VI

# APPENDIX VI

## MEMBERS AND PARTICIPANTS

### MEMBERS

Lt Gen J. H. Doolittle, USAF(Ret)
Chairman of the Board
Space Technology Laboratories

Dr. John S. Foster, Jr.
University of California
Lawrence Radiation Laboratory

Prof. David T. Griggs
Institute of Geophysics
University of California

Dr. Conrad Longmire
Theoretical Division
Los Alamos Scientific Laboratory

Dr. Gerald M. McDonnel
University of California at
Los Angeles Medical Center

Gen E. E. Partridge, USAF (Ret)
Lockheed Aircraft Corporation

Dr. Simon Ramo
Executive Vice President
Thompson Ramo-Wooldridge, Inc.

Dr. Theodore B. Taylor
Senior Research Advisor
General Atomics Division
General Dynamics Corporation

Dr. Edward Teller
University of California

Gen N. F. Twining, USAF (Ret)
Chairman of the Committee

Dr. Stanislaw M. Ulam
Los Alamos Scientific Laboratory

Prof. John A. Wheeler
Palmer Physical Laboratory
Princeton University

### RAND CORP. PARTICIPANTS

Dr. Albert L. Latter
Dr. Richard Latter
Dr. William G. McMillan

DOD PARTICIPANTS

Dr. Gerald W. Johnson
Assistant to the Secretary
(Atomic Energy)

MILITARY PARTICIPANTS

Maj Gen Robert A. Breitweiser
Assistant Chief of Staff,
Intelligence, Hq USAF

Maj Gen William B. Keese
Deputy Chief of Staff/Plans
Air Force Systems Command

Maj Gen Seth J. McKee
Director of Plans
Strategic Air Command

Maj Gen Jerry D. Page
Deputy Director of Plans
for Aerospace Plans, Hq USAF

Maj Gen James F. Whisenand
Assistant DCS/Research and
Development, Hq USAF

MILITARY PARTICIPANTS (cont)

Brig Gen Glenn A. Kent
ODDR&E

Colonel Joseph O. Fletcher
Directorate of Plans
Hq USAF

Colonel Ola P. Thorne
Assistant for Nuclear Energy
DCS/Research and Development
Hq USAF

SECRETARIAT

Lt Col Kent P. Howard
Scientific Advisory Board, USAF